

**Leonardo da Vinci programme
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Writing in English

**A Practical Handbook for Scientific and Technical
Writers**

A Pilot Project

Project Partners

Zuzana Svobodova, Technical University Brno, Czech Republic
Heidrun Katzorke and **Ursula Jaekel**, Technische Universität, Chemnitz, Germany
Stefania Dugovicova and **Mike Scoggin**, Comenius University, Bratislava, Slovakia
Peter Treacher, ELT Centre, University of Essex, England

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Foreword

No science stands alone. If research done, findings found, conclusions drawn are not presented to the world then it is arguable whether they are of any real use at all. The reason for the research paper is to present the findings to the world, to share the information learned for others to do with it what they will. Why the research was originally conducted is of interest, but the researcher's intentions, goals and conclusions are not the end.

For example, a zoologist's published observations of the chemical means of trail marking by ants may be read by a biochemist, who in turn researches the make-up of the chemical. These findings are then read by a chemist who synthesises the chemical and through that research finds a means of bonding that is both durable, but removable. Meanwhile a scientist in robotics reads the zoologist's work and other possibilities arise. This roboticist creates a robot that can detect and respond to chemicals applied like paint to the floor, solving the problem of how to guide and instruct robots on their mail-delivery rounds through an often-changing maze in an assembly plant. No research stands alone. No researcher can foresee all of the consequences and ramifications of their work. All science is interdisciplinary. This is why research results and findings are published.

Since no one knows what impact the research might have, and on whom, the work must be published in a way that is easily accessible not only for fellow researchers in the particular field, but to everyone. The work must be presented in an ordered, conventionally agreed upon way. A research, technical or scientific paper is not the place for creative or artistic writing, but for the organised, logical, deliberate dissemination of knowledge. The researcher did the research; the reader should not have to.

This handbook has been designed to be a reference book and guide for researchers who have to write up their scientific work in English and who may need help to compose and write more clearly and accurately in the language. At present it is only a pilot version and the final edition will be ready during 2001. Your comments on the usefulness of this draft will be invaluable to the compilers, who are:

Zuzana Svobodova, Technical University Brno, Czech Republic
Heidrun Katzorke and Ursula Jaekel, Technische Universität, Chemnitz, Germany
Stefania Dugovicova and Mike Scoggin, Comenius University, Bratislava, Slovakia
Peter Treacher, ELT Centre, University of Essex, England

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Chapter 1

TYPES OF WRITING

In this chapter we outline some of the main differences between certain important kinds of scientific and technical writing. These are

- scientific articles
- research papers
- proposals

1.1 Scientific Articles

Scientific and technical articles and essays are mainly published in journals, magazines and newspapers. They are normally intended to reach a wider audience than research papers.

Thinking about your audience

How scientific articles are written depends on who the readers are likely to be. A more scholarly, academic or discipline-specific journal will allow specialised vocabulary, while a piece in a more popular magazine, for example, will present and explain the data in an accessible manner for a wider audience. The writer must know what kind of people he or she is writing for.

The structure of a scientific article

Articles and essays need to be a seamless whole: paragraph flowing into paragraph, ideas presented smoothly in logical order. Structurally they can be broken down into these three parts:

- The introduction
- The main body
- The conclusion

Each of these is covered in a section in Chapter 2 on *Composition*.

Articles and essays need to be well thought out and ordered. How the writer introduces the piece, builds on the introduction through the body, and concludes will largely determine how the information is accepted. Step by step, the writer must present main ideas, supporting evidence, analyses and conclusions in a logical and organised manner. The writing must not wander, but keep to its task of presenting the writer's information in the clearest possible way.

Style Manuals

Every discipline has its own style standard. These *Style Manuals* are published and readily available for each field, science and discipline. Writers are responsible for knowing and following the standard of their own particular discipline.

1.2 Research Papers

Research papers are generally written for scientists working in the same field and therefore have a more limited, and more specialised, readership than articles. Research papers can appear in specialist journals or be presented at conferences.

The structure of a research paper

A research paper has a more closely defined structure than an article or essay. There are normally 8 sections in a research paper or scientific report, and these tend to follow each other in a fixed sequence. Obviously these may vary, depending on the nature of the research done. Each element is further described and explained in Chapter 2 *Composition*.

- **Title**
It must precisely describe the report's contents
- **Abstract**
A brief overview of the report
- **Introduction**
Includes the purpose of the research
States the hypothesis
Gives any necessary background information
Provides a review of pertinent literature
- **Methods and materials**
Provides a description of material, equipment and methods used in the research
- **Results**
States the results of the research. Visual materials are included here.
- **Discussion**
Evaluation and interpretation

Was the hypothesis supported? If so, how? If not, why not? Relevant results are cited in support.

- **Conclusion**
Conclusions to be drawn from the results
Conclusions about the hypothesis
Implications of the research and results
Additional research proposed
- **References cited**
A list of the references cited
Include references to any works cited in the review of literature in the introduction.
Use the documentation style required by your specific field. (See Sections 2.9 on *Referencing* and 4.8 on *Quoting*)

1.3 Proposals

Proposals may well be the least popular form of writing for researchers but they are necessary. The purpose of a proposal is to ask for funding in order to make research possible. As there is only a limited amount of money in the world for research, you need to make the case for your particular research as effectively as you can.

Purpose of a proposal

A proposal must demonstrate that your research project is worth the time, effort and money to accomplish it. It must make the need for money and time easily understandable and it must propose an appropriate recipient for the funding.

- A proposal persuades.
- A proposal requests.
- A proposal promises that the project will be completed.
- A proposal states the researcher's commitment to doing the work.
- A proposal presents a detailed plan to accomplish the research.

Components of a proposal

Although there is variation according to the organisation you are applying to, a proposal will probably consist of these elements.

- **A cover letter.** This is one page long, separate from the main proposal. It introduces:

- * the researchers -- you
- * the reason for your research – the needs and the problems that the research is to meet.
- * the cost of the research
- * the length of the research
- * the benefits of the research (including to the prospective donors)

- **A title page.** The title page is one sheet of paper. It contains:

- * the project title
- * the recipient of the proposal, that is, the organisation, and if possible the individual
- * the date
- * the person or persons submitting the proposal, including signatures
- * a contact person (name and title, address, telephone number, and e-mail address)
- * the project budget total
- * the project time span

- **A table of contents.**

This is only necessary if the proposal is over 15 pages long. It should be on a single page.

- **A summary**

By its very nature this must be written last. It should only be between 150 and 300 words (2 paragraphs) long, and include points in the cover letter.

- **An introduction.** Use the introduction to establish the need for the research and the credibility of the researchers to do it. Include:

- * Background on the need to be addressed by the research
- * Background on the researchers and their organisation (including degrees, titles and achievements)

- **A needs assessment.** This section should answer these questions:

- * What is the need motivating the research?
- * How is the research expected to meet the need?
- * Why should you be the one to do the research? What are your qualifications for it?

- **Objectives.** This section should answer these questions:

- * What is the goal of the research?
- * What are the expected results?
- * What are the expected benefits and applications resulting from the research?
- * How do the objectives meet the needs?

- **Methods.** This section should answer these questions:

- * How will the research specifically be conducted? Justify the methods proposed.
- * What is the time-frame for the research project? Justify the schedule proposed.

- **Pre-evaluation.** This section should answer these questions:

- * How will the project be evaluated? Internally or externally?
- * What data will be gathered? How will it be gathered?
- * What is the expected extended length of the project, beyond the scope of the immediate proposed funding?
- * How will the results be disseminated?

- **Long-term financial plans.** The answers in this section should be specific and detailed. This section should answer these questions:

- * If the project extends beyond the length of the grant, how will it be funded?
- * Will the project be able to be wholly or partially self-supporting?

- **Budget.** This section should answer these questions:

- * What materials are needed for the project and what will they cost? This must be itemised, specific and detailed.

- **Personnel.** This section should answer these questions:

- * Who will be involved in the research, and why? (Be specific)
- * What specifically are the duties and responsibilities of the researchers involved?

- **Appendices.** Each appendix should be a separate section. Possible appendices include:

- | | |
|---|-----------------------------|
| * Résumés of the researchers | * References |
| * Board members of applying organisations, or body of researchers | * Letters of support |
| * Charts of the organisation | * Applicable bibliographies |
| * Applicable charts, graphs and tables | |

Chapter 2

COMPOSITION

2.1 Titles

The purpose of a piece of scientific writing is to present information clearly and concisely so that it can be easily understood. Clarity therefore begins with the title.

In scientific and technical writing, a poetic or stylized title does not help the reader at all. For example, the following title

The Kopje Drummers of the Karoo

does not tell the reader that the paper is about birds, woodpeckers to be exact. However, this title

The mating rituals of *Geocolaptes olivaceus*, South Africa's Ground Woodpecker

tells the reader very clearly what the subject of the paper is.

Elements in a title

In technical and scientific writing the title is a precise description of the contents. It should include specific words to indicate the following:

- **the topic**, that is, the main, general subject you are writing about
- **the focus**, that is, a detailed narrowing down of the topic into the particular, limited area of your research
- optionally, for a scientific article, **the purpose** of your writing. This means including a word such as the following, which tells the reader what kind of argumentation to expect:

An analysis of ...	An assessment of ...	A comparison of ...	A description of ...
A discussion of ...	An evaluation of ...	An explanation of ...	An outline of ...

Some sample titles:

purpose	topic	focus
An analysis of	carp culture management	as a tool for Mexican crayfish conservation.
An overview of	nutritional needs	before, during and after an endurance event.
A discussion of	genetic engineering technology	and its effects on the environment.
An evaluation of	sewage treatment	as a tool in environmental protection.

Punctuation of titles: capital letters

- It is clearer to type your title in lower case rather than in capital letters.
- Use capital letters for the first letter of all the main words in the title, including nouns, pronouns, verbs, adjectives, adverbs, longer prepositions, conjunctions
- Do not use capital letters for short structural words (except when they are the first word of the title), such as articles (*a, an, the*), short prepositions (*of, in, to, at*), co-ordinating conjunctions (*and, or, nor, but, for*)

Points to check in your own writing

- *Be precise and concise; strive for clarity and avoid terms with multiple meanings which might lead to misunderstanding*
- *Use key words from the paper to inform readers of the content, but try not to choose too many technical words as this will not attract a wider audience*
- *Titles stand alone; they are not a part of the opening sentence or paragraph*

2.2 Planning your Writing

A primary tool for a writer is making a plan or outline before starting to write. Planning enables you to:

- organise your thoughts efficiently
- decide on the most effective way to present your information.
- keep to a logical sequence of points and not wander off on a tangent
- remember all the information that must be included
- cut out unnecessary or irrelevant bits

Of course a plan can be changed. Writing is an exploratory process and as the piece is being written and assembled the outline can be amended to take account of additional points or to change emphasis. A plan is simply a tool to ease the writer's task: it should remind you of what to do, not dictate to you.

Different kinds of plans

- **A simple plan.** Only the main points are jotted down in an order that best serves the argument and information sharing of the paper.
- **A complete plan.** Below the main points of the simple plan, you can list more specific points. Generally you do not have to be over-specific, but this is a way of making sure that the detailed points you want to make are not forgotten.
- **A question plan.** In these you write down the questions that you are trying to answer at each stage of your work. This form helps you to understand the reader's position and may help focus the plan and organize your strategy.
- **A sentence plan.** A simple sentence summarising the main point of each paragraph and section. These give you direction, and can sometimes form the first or 'topic' sentences of your paragraphs.

Putting your ideas in order

Written work must be ordered. Though information and ideas may come to you randomly, it is your job as a writer to clarify and structure your data and present it in a sane, sensible and logical fashion. Here are some points to think about when planning, selecting and sequencing your material:

- Have a goal, a main idea and intent. Every idea, sentence and paragraph must lead towards that goal effectively. Stick to the matter at hand; omit anything that does not lead towards the goal, no matter how interesting.
- Have a reason for ordering your paper as you do, and then convince the reader of your argument by developing it smoothly and logically.
- Each idea and concept (with its substantiation) should flow logically from one to the next.

Different ways of ordering your material

chronological or sequential	Step by step. Points are made one after another in the order of occurrence.
from simple to complex	Used when proving an assertion made in the introduction. Each step builds on the one before, from the obvious to the complicated, building the reader's understanding gradually. It builds naturally to a climax in the conclusion.
from complex to simple	Used when urging the reader to apply a solution to a problem. It states the problem, and then begins to direct towards a specific solution.
from general to specific	Used when contrasting and comparing, from similarity to difference.
from specific to general	Used when contrasting and comparing, from difference to similarity.

Layout of a sample plan

In a typical layout, a combination of numerals and letters are organised in a hierarchy. For example:

- Roman numerals (I, II, III, IV, V ...), signifying main points
- capital letters (A, B, C, D ...)
- Arabic numerals (1, 2, 3, 4 ...)
- lower case letters (a, b, c, d, ...)
- numerals in parentheses ((1), (2), (3), (4) ...)
- lower case letters in parentheses ((a), (b), (c), (d)...))

In the text each lower level is indented further.

I					first main point
	A				part of I
		1			part of I.A
			a		part of I.A.1
				(1)	part of I.A.1.a
				(a)	part of I.A.1.a.(1)
				(b)	part of I.A.1.a.(1)
				(2)	part of I.A.1.a
				(a)	part of I.A.1.a.(2)
			b		part of I.A.1
				(1)	part of I.A.1.b
		2			part of I.A
			a		part of I.A.2
	B				part of I
		1			part of I.B
II					second main point

The plan continues ...

2.3 Paragraph Writing

Paragraphs are the essential building blocks of your writing. They mark the flow of your argument, with each paragraph focusing on one main idea and a cluster of connected sentences to expound upon and amplify it. Your argument progresses by moving from the main idea in one paragraph to the main idea in the next. Paragraphs also provide the reader with *visual* help in following your argument as they appear as separate blocks of text on the printed page.

Length of a paragraph

- There is no ideal length that can apply to all paragraphs since length depends largely on the content. However, as a general guide, it is helpful to the reader to keep most of your paragraphs to between seven and fourteen lines in length (say, between three and six or seven sentences).
- Occasionally paragraphs can be shorter than this (where a point needs to be made briefly or with special emphasis) or longer (where more detailed elaboration of a point is needed).
- For the reader, too many short paragraphs make your writing too bitty, while too many long ones makes it rather heavy and difficult to follow.

Number of ideas in a paragraph

There is normally only one main idea in each paragraph and this is expressed in a **topic sentence**. The other sentences support and expand on the idea in the topic sentence in different ways. The last sentence can often be important too, as it can be used to summarise the gist of the paragraph.

Placing the main idea in the paragraph

The ‘topic sentence’ is usually the first sentence in the paragraph, though it can be the second (when the first is used as a kind of introduction). You can test this by ‘skimming’ an article quickly, just reading the first sentences of each paragraph, and seeing if you can follow the overall development of the argument. Normally, you can.

Structure of a paragraph

There is no single pattern that will apply to all paragraphs. Following the topic sentence, the other sentences can have a variety of functions, e.g.:

- clarifying or re-stating the main idea
- explaining the idea
- qualifying the main point in some way
- providing examples
- giving supporting evidence
- commenting on the main idea.

There is also some linking, either stated or implied, with the previous and the following paragraphs.

Sample paragraph

The following paragraph can be analysed to show its structure and the functions of the 8 sentences. (The numbers are inserted only to identify the sentences)

(1) *The Ultra Long Duration Balloon is a super-pressure, or “closed” balloon, which is not vented to the atmosphere like conventional balloons.* (2) *Usually fabricated from stronger materials such as polyester, super-pressure balloons are inflated like their zero-pressure counterparts and then sealed.* (3) *Once a super-pressure balloon reaches the desired altitude, the sun’s heat forces the internal pressure to rise until it exceeds the outside ambient pressure.* (4) *As a result, the differential pressure between the inside and the outside increases.* (5) *At night when the gas cools, the differential pressure drops, but if enough gas has been put into the balloon the differential cannot drop below zero.* (6) *In this way, the balloon remains full and at a stable altitude without having to drop ballast.* (7) *So long as the balloon remains impervious to helium or hydrogen molecules, it can stay aloft.* (8) *Accordingly, super-pressure balloons can be used for flights of far greater duration than zero-pressure systems.*

I. Steve Smith, Jnr. & James A. Cutts “Floating in Space” *Scientific American* Vol 281 No 5 November 1999

Analysis

- * (1) is the topic sentence – contrasting the Ultra Long Duration Balloon with conventional ones
- * (2) - (7) explain how the ULDB works. (2) describes the special features of its construction. (3) and (4) explain how it operates in the air, with (5) adding what happens at night. (6) and (7) summarise its operation.
- * (8) provides an overall conclusion – the ULDB can stay in the air longer than conventional balloons

Points to check in your own writing

Here are some simple tasks for you to see if you are constructing paragraphs properly.

- *Take one or two pages of your academic writing. Do a 'visual' check on the length of paragraphs – does the text look too heavy or too 'bitty' or about right?*
- *Check whether the average length of the paragraphs is between 7 and 14 lines (3 to 7 sentences)*
- *Count the number of words in randomly selected sentences. Does the average number of words come to between 15 and 25? If so, this is about right.*
- *Do the 'skim' test: read through the first sentences only of your whole text and see if you can follow the gist of your argument. If you can, you are writing your topic sentences well.*

2.4 Introductions

This section covers two forms of introductions:

- introduction to an article
- introduction to a research paper

Introductions to articles

The introduction does more than tell the reader what the subject of the paper or article is, though obviously it must do that. It must also capture the reader's attention at the beginning, or they will never continue to the end. A good introduction gets the reader wanting more.

Points to include in an introduction

In the introduction to an article you present your topic in general, then narrow the focus on the topic and make a clear **thesis statement**. Your thesis statement expresses the central idea of your paper. Everything else you write flows from this and depends on it. The thesis statement needs to be clear, and concisely and precisely stated.

Topic, Topic Sentence, Thesis, Hypothesis

These terms are all often associated with introductory paragraphs. They are different and not all are found in every type of paper.

- *Topic*
It is the subject of the paper. *Chemistry or Amino Acids, Biology or Aquatic Invertebrates* could all be topics.
- *Topic sentence*

It states the topic of the paragraph; in an introduction it states the topic of the paper. It is generally at the beginning of a paragraph.

- *Thesis*

A proposition phrased in a thesis statement. In the thesis statement the whole of what the writer is arguing is said in one clear and concise sentence.

- *Hypothesis*
A conjecture, a tentative or working theory, proposition or explanation used as a premise for reasoning, argument or investigation.

A hypothesis proved false is as important as one proved true.

Sample introduction to an article

The Use of Hemp in Reprocessed Paper Manufacture

As recycling paper becomes more common throughout the world, new uses for the reprocessed product are increasing. Paper bags and cardboard boxes, the pages of the latest best-selling paperback, disposable cups, paper towels and toilet paper all use recycled paper with varied effectiveness. The paper bags tear easier than those made of virgin paper. The paperbacks begin to crumble in a few short years, the paper towels break down quickly into mush and the paper cups leak before the coffee has even had a chance to cool. It is the nature of recycled paper. In the recycling process the waste paper is broken down and reformed. A result of the process is that the new paper has shorter fibres and is more brittle, with less tensile strength than the original paper.

Finding ways of adding strength to the recycled product, thereby making it a more usable and reliable material, has given rise to a whole research industry. Scientists are exploring changes to the recycling processes hoping to do less damage to the fibers. Additives to the paper are being tried at different stages of manufacturing with mixed results. The adding of non-recyclable materials to the papers does make them stronger, but defeats the purpose.

*Finding suitable materials that meet the structural, recyclable and cost effective requirements are driving more and more researches to marijuana. No, not to smoke but for the fibres found in the marijuana plants. Marijuana, or Hemp (*Cannabis sativa*), fibres are proving to be one of the most promising recyclable additives. Papers with hemp fibres added in the pulp stage are proving to be stronger and more durable than those made of recycled paper alone. Hemp is the solution for the paper industry, certainly to the structure problems of recycled papers.*

Analysis of the introduction

- The introduction presents the topic *Recycled Paper* by stating very general information that most readers are already aware of.
- The topic is narrowed down to a particular problem with recycled paper: its lack of structural strength.
- This is then further narrowed down to a thesis statement, saying that hemp is the solution to the problem.
- Note that the writer suggests that hemp may perhaps have something more to offer the paper industry than just its strength
- Note how the writer goes beyond the basic information in order to capture the reader's attention by planting a **hook**. Here the hook was *Marijuana*. A hook causes the reader to pause and pay attention, here to find out what marijuana has to do with recycled paper. The writer goes on to explain that it is a specific product of the hemp plant, fibre, that is a solution to the problem of weak and brittle recycled paper.

Introductions to research papers

Introductions to scientific research papers differ from those in articles in certain respects:

- In papers, the introduction is direct and to the point. It is therefore somewhat shorter than in an article, maybe only one paragraph long.
- In some papers, the introduction is actually a named section of the paper. It follows the title, and in this case it is itself entitled 'Introduction'.
- It may have additional paragraphs containing a review of the literature and any pertinent background information. Even though it is a section, you should still be brief.
- Although you need to capture the reader's interest as in an article introduction, you should avoid anecdotes and illustrations. You need to
 - * tell the reader what the paper is about
 - * say what the paper contains and says
 - * explain why what it says is important and worth reading

Points to be covered in the introduction to a research paper

The introduction to a research paper should involve the reader by answering these questions:

- What was your reason for doing the research? What in general was the research attempting to find out?
- What was your hypothesis or thesis? What specifically was the research attempting to prove?
- What background information is pertinent to an understanding of the paper?
- What literature is pertinent? What other studies have explored the subject? (Note that all literature must be fully documented. See Section 2.10 Referencing)

Example of an introduction to a research paper

As recycling paper becomes more common throughout the world, new uses for the reprocessed product are increasing. In the recycling process the waste paper is broken down and reformed. A result of the process is that the new paper has shorter fibres and is more brittle, with less tensile strength than the original paper. Finding ways of adding strength to the recycled product, therefore making it a more usable material was the purpose behind this research project.

This passage would then be followed by a thesis statement or by a hypothesis.

- A sample **thesis statement** for this opening would be:

Recycled paper products with added Hemp (*Cannabis sativa*) fibres are stronger and more durable than products made of recycled paper alone.

Your thesis statement expresses the central idea of your paper. It is your conclusion, and the rest of the paper has to prove it through evidence and examples. The thesis statement needs to be clearly, concisely and precisely stated.

- Many research papers propose a **hypothesis** instead of a thesis statement, especially if they are presenting research and findings and the conclusions are only tentative. The hypothesis states succinctly what the research is attempting to prove and this directs the structure of the experiment.

A hypothesis for the above research might be:

It was hypothesised that the longer fibres of the Hemp plant (*Cannabis sativa*), when added to the shorter recycled paper fibres during the manufacturing process, will result in stronger recycled paper products.

Sample phrases you can use in introductions

- **Stating your purpose**

In this paper, it will be shown that ...
In this paper, ... will be discussed / are considered.
The present paper examines / presents ...
In this article, we report on ...
Our / My intention here is to highlight ...
In the following pages, we shall propose ...
This article will concentrate / focus on the arguments ...
The key question that this article will address is whether ...
This paper will report on work already carried out in this area.

- **Relating your paper to current work**

*In recent years, ... has become a topic of lively debate.
The issue of ... has become controversial recently.
The question of ... has been thoroughly researched over the last few years.*

- **Indicating the structure of your paper**

*The article has (6) main sections.
Firstly, we shall examine the question of ...
The next section briefly outlines ...
After a short discussion of ..., an overview of ... will be given.
This will be followed by ...
The final section will present ...
I / We shall then go on to suggest ...*

Points to check in your own writing

In the introduction to an article

- *Topic – have you made it clear to the reader what the topic of the paper is?*
- *Have you captured the reader's interest by using a 'hook'?*
- *Thesis statement – does the reader clearly know the thrust of your argument? Is it stated clearly in one precise sentence?*
- *Does the introduction effectively introduce the rest of the article? If not, rewrite it.*

In the introduction to a research paper

- *Have you stated the topic and the purpose of the research?*
- *Have you expressed your hypothesis or thesis statement clearly, concisely and precisely?*
- *Have you eliminated everything, such as anecdotes and illustrations, not specifically to do with the topic.*
- *Have you given enough background information or reviewed all the pertinent literature?*
- *Have you expressed everything as succinctly and briefly as you can?*
- *Finally, after finishing the whole paper, review your introduction. Is it in the right style and tone for the rest of the paper?*

2.5 Writing the Main Body

This section deals primarily with scientific and technical articles, though much of what is written applies to the introduction, discussion and conclusions sections of a research paper.

Types of articles

There are three main kinds of articles and essays. The writer needs to know which type best serves his or her purpose.

- **Informational or Expository**

This type of writing focuses on presenting information, not to persuade but to inform the reader. There should be a minimum of bias. Though the writer is not presenting an argument, the paper still must have a goal: the effective sharing of information.

- **Explanatory**
This type of writing not only presents information, but also provides an explanation or rationale for it. This too should have little or no bias as the goal is to help the reader understand data better.
- **Argumentative or Persuasive**
In this type of writing, the writer does have a viewpoint and is trying to persuade the reader to agree with it. The arguments are planned and thought out logically, in a sequence designed to bring the reader to the writer's conclusion.

Coherence in your writing

- The paper must be a whole. Each sentence should follow on logically from the previous one and lead into the next one, as does each paragraph, idea, concept, argument and example, on to the conclusion.
- For each section, decide what the function of your writing is at that particular stage. Refer to the sections in Chapter 4 *Language Functions* for suggested words and phrases to help you in your writing.
- You should not include anything that does not directly contribute to your goal. Fascinating but unrelated bits of information must be omitted. Illustrations, examples or interesting anecdotes that are not directly relevant must be edited out. They do not add interest; they sidetrack the reader away from what you are trying to achieve.
- Use 'linking' language to help the reader see what connects one point of the argument to another. (see Section 3.5 *Signposting*)
- Maintain the same style of writing throughout. This includes maintaining the same level of formality. If you decide to change your tone while actually doing the writing, then go back over what you have already written to make sure that the whole piece has the same tone. (see Chapter 3 *Style*)

Use of illustrations

- In an essay or article there are generally fewer charts, graphs, tables and other graphics. They are used only if they are the best way of conveying the information.
- In an essay or article, artwork and photographs are more commonly used than in a research paper.
- In an essay or article most illustration is verbal. While they generally have no place in a research paper, in an essay or article stories and anecdotes may be used to hook the reader, maintain interest, and illustrate by example an argument, concept or idea.

Drafting and re-drafting

Remember that you should write, rewrite and rewrite again.

- A first writing is *not* good enough. It must be improved.
- A second writing will expose the most obvious errors.
- A third polishes. Better words, clearer thoughts and more apt illustrations will present themselves to the writer.
- If possible, do a fourth.

If possible, between drafts leave the piece. It is amazing what time will expose in even the most perfect prose.

Points to check when writing or re-drafting an article

- *Is your thesis statement clear and understandable?*
- *Are the tone and vocabulary suitable for the intended audience?*
- *Consider only the first and last paragraphs. Can the reader understand the gist of the whole by reading just these two paragraphs? Does the final paragraph merely restate the first paragraph? If it does, rewrite it.*
- *Have you used the right arguments, language and style to persuade the reader to agree with you?*
- *Have you expressed yourself exactly and precisely? This is of ultimate importance in scientific writing.*
- *Have you checked for grammatical accuracy, e.g. consistent verb tenses, use of articles?*
- *Have you checked your spelling?*
- *Have you followed the appropriate Style Manual?*

2.6 Conclusions

This section covers the following two forms of conclusions:

- the conclusion to an article
- the conclusions to a scientific and a technical paper

Article conclusions

A good introduction encourages the reader to read on; it sets the tone for the article but it may fade in the reader's memory. What is remembered, on the other hand, is the conclusion. The conclusion should be an anchor in the reader's mind, a place where the whole of the essay is attached; a weak ending soon loses its hold and the essay is forgotten.

The last paragraph is a conclusion, an ending, not just a stopping. It should not simply be a repetition of the introduction, but should take account of all that has been developed in the main body. However, it is also not just a summary of your main points; it is the ending, so you should add something extra, something to 'complete' the work, to round it off.

Points to include in a conclusion

- **What you may include in your conclusion**
 - * a summary of your main points, but written in a different way, so that the reader can get a different perspective on them
 - * your evaluation of the topic - this may be a restatement of your introduction, or modified in light of the evidence
 - * an amplification or extension of your thesis statement, logically following on from your main points in the body
 - * your proposed solution to the problem you have discussed
 - * a reconciliation between two opposing points of view
 - * suggestions for further investigations into the topic or issue
- **What you should not include in your conclusion**
 - * the presentation of your thesis statement
 - * completely new evidence or points in support of your thesis statement
 - * the start of a new topic

- * anything which requires a detailed exposition
- * an opposing argument which puts into question or undermines your own

Example of a conclusion

Refer back to the sample introduction in Section 2.4 on the subject of

The Use of Hemp in Reprocessed Paper Manufacture

After the introduction, the body of the paper presents arguments for the use of hemp:

- The recycling process and the structure of the hemp plant are briefly explained.
- It is said that comparatively fewer natural and human resources are used to grow hemp rather than a tree to produce the same amount of fibre.
- Other paper additives are discussed and shown to be less acceptable and cost effective than hemp.
- Hemp is offered as an alternative to wood-based papers altogether.
- Other uses of hemp are briefly mentioned, pointing out that the plant is more than a solution to a single problem.

Sample conclusion

Society tends to view certain topics through narrow lenses and from one viewpoint, as either black or white, good or evil – but the viewpoints and attitudes change. In the recent past, hemp was primarily considered a fibre for use in ropes and fabrics, but with the rise of the counter-culture of the mid-twentieth century and its focus on drugs, the lowly source of fibre, hemp, became the infamous marijuana, pot, dope. It was stigmatized, outlawed and vilified, forced into hiding. Today that attitude bears re-evaluation.

Apart from the medicinal qualities of marijuana, its other practical applications surely warrant a second look at the plant and the controversy surrounding it. Today, new varieties of hemp are available which are easily and quickly grown and resource-stingy but do not have enough THC (*tetrahydrocannabinol*) to have any narcotic or intoxicating effects, yet society still fearfully turns its back on one of the least expensive, most versatile natural fibres available.

As societies seek ways to protect the forests and the environment as a whole, abandoning such a useful and environmentally friendly raw material as hemp seems particularly shortsighted. Still, this is not the first, and doubtless not the last, time that society has turned its back on the potential benefits of something because it has already acquired a bad name.

Points to note

- The conclusion is mainly a comment on what the paper has said, drawing conclusions.
- After devoting the paper to supporting and promoting the qualities of hemp, the author briefly and effectively deals with the opposition to the plant.
- The author then finishes with a last appeal that pointedly leaves the readers to re-evaluate their attitudes about hemp.

Research paper conclusions

In a research paper 'Conclusions' is a separate section, as is the Introduction. It is clearly labelled Conclusions, and follows the sections Methods and Materials, Results, and Discussion.

In most ways the Conclusion section of a research paper is easier to write than that of an essay or article. It must contain four straightforward elements:

- Conclusions about the hypothesis posed in the introduction

Did the hypothesis prove to be correct or incorrect? How? Why? How may the problem be re-hypothesized?

- Results of the research – and their theoretical implications

What did the research actually reveal? What was observed? Not only what do the findings indicate about the research done, but also what broader aspects might they reveal and explain?

- Possible hypotheses raised by the results

What questions do the results raise? What possible answers or explanations can be hypothesised?

- Specific lines of additional research raised by the results

At each step of the research new questions arose; how might they be answered or explained?

How these conclusions are presented depends on the research done and the demands of the Style sheet for the particular field.

Sample phrases you can use in conclusions

- **Summarising what you have done**

In conclusion, we can say that ...
In this paper, we have seen that ...
This research paper has clearly shown that ...
The discussion in this article has given an overview of ...
This paper has provided a systematic study of ...
From the research that has been carried out, we can conclude that ...
The aim of the present paper was to examine whether ... and this has now been achieved.
Finally, it is worth pointing out that ...

- **Indicating the limitations of your own work**

This article has only been able to touch on the most general features of ...
Even a preliminary study, such as the one reported here, has highlighted the need for ...

- **Looking to the future and further research**

Clearly, further studies are needed to understand / prove ...
In order to validate the work we have carried out, a more in-depth investigation into ... is needed.
The results of this research could assist policy makers to ...

Points to check in your own writing

- *Can the reader understand the gist of your paper by reading only the introduction and the conclusion? If not, re-write them.*
- *Have you merely re-stated what you said in the introduction? If so, think how you might present it somewhat differently in the light of the supporting evidence in the main body.*
- *Do you conclude with an emphatic finish? Do you leave the reader with a strong impression?*

2.7 Sections of a Research Paper

Between the Introduction and the Conclusion, the main body of a research paper normally consists of these three sections:

Methods and Materials

- In this section the researcher cites all the specifics of the work done. Every detail needs to be included. The reason that this section must be completely documented is so that other researchers can duplicate the studies and hopefully duplicate the findings. Variables matter and need to be detailed. The failure to list pertinent particulars will throw all of the research and conclusions into question.
- Methods and Materials answers the following questions:

Where?	Location of the work, if relevant.
What?	What equipment and other materials were used in the research. They need to be thoroughly specified.
How?	The procedures and methods used in the research. Every detail should be included.

Results

- This section follows Methods and Materials.
- In this section you present the precise data and findings from the research, often using visuals to provide the information.
- Data may be effectively presented in charts, tables, graphs, diagrams and photographs. These should be accompanied by explanatory text to highlight and interpret significant facts. See Section 2.8 *Describing Tables and Graphs* for examples of appropriate language to use.

Discussion

- This section follows Results.
- In this section you write about your interpretation of your findings and your evaluation of the research.
- In particular, you give your opinion as to whether the work supported and proved your hypothesis, or whether it did not.
- You can also explore
 - * the success or failure of various research methods
 - * how the studies might have been done differently to investigate the problem better

Questions to be answered in the Discussion section

Did the research support the hypothesis? If not, why not? (Be specific, cite examples)

What interpretations can be made from the results? (Be specific, cite evidence)

Were the research methods adequate? If not, why not? (Be specific, cite evidence)

How could the research be done differently to cross check the findings? (Be specific)

2.8 Describing Tables and Graphs

Probably the most important thing to keep in mind when describing graphs and tables is how to convey the information properly and accurately. Surprisingly, relatively few key words or grammar elements are needed when describing trends or movements. The following vocabulary items can be used:

To go up (a little)	
Nouns	Verbs
an increase	to increase
a rise	to rise
a growth	to grow
an improvement	to improve
an upturn	
	to go up
an upward trend	

To go down (a little)	
Nouns	Verbs
a decrease	to decrease
a fall	to fall (off)
a drop	to drop
a decline	to decline
a downturn	
	to go down
	to slip
a downward trend	

To go up (a lot)	
Nouns	Verbs
a surge	to surge
an upsurge	
	to take off
	to shoot up
	to soar
	to rocket
a jump	to jump
a leap	to leap

To go down (a lot)	
Nouns	Verbs
	to plummet
a plunge	to plunge
a slump	to slump
a crash	to crash
	to sink
a tumble	to tumble

No change
to remain stable
to level off
to stay at the same level
to remain constant
to stagnate
to stabilise

Change of direction	
Downward	Upward
to peak	
to reach a peak	to reach a low point
to top out	to recover
	to rebound
	to revive

To describe the degree of change			
Adjectives		Adverbs	
a dramatic	rise or fall	to rise or fall	dramatically
considerable			considerably
sharp			sharply
significant			significantly
substantial			substantially
moderate			moderately
slight			slightly

To describe the speed of change			
Adjectives			Adverbs
an abrupt	rise or fall	to rise or fall	abruptly
a sudden			suddenly
rapid			rapidly
quick			quickly
steady			steadily
gradual			gradually
slow			slowly

2.9 Referencing

Not everything in your writing need be documented. Facts and ideas that are 'common knowledge' (and not from a quotation), as well as your own thoughts, opinions and conclusions do not need to be documented. But whenever you rely on an idea or the writing of someone else in support of your own thesis, this must be credited. If you fail to do this, you will be guilty of plagiarism. (See Section 2.10 *Plagiarism*)

Types of references

As well as referring to another work within your text (see Section 4.8 *Quoting*), you have to give more details about your sources in one or more of these places:

- **Footnote**
 - * provides details about the source of an in-text citation
 - * placed at the bottom of the page where the citation appears
- **Endnote**
 - * provides details about the source of an in-text citation
 - * placed at the end of the article or paper, on a separate sheet of paper
- **Bibliography**
 - * complete list of reference books, articles and other source materials cited in your work, in alphabetical order by author
 - * placed at the end of the article or paper, on a separate sheet of paper

Style sheets

Every publisher and discipline has its own requirements and provides style sheets on how references should be laid out, even though they all require the same basic information. These style sheets are readily available, and provide style standards for writing in most fields, sciences and disciplines. As a professional writer, you are responsible for knowing and following the standard of your particular discipline.

Format of references

The basic guidelines below apply to how you lay out the details about a source in a footnote, an endnote or a bibliography. For how you actually cite a source in your text see Section 4.8 *Quoting*.

The examples given follow **APA style**, as governed by *The Publication Manual of the American Psychological Association*. Check whether this style actually applies to your own discipline.

- **Reference to a book.** Information to include:
 - * names of the author(s): surname first, with initials for given names
 - * year of publication, in parentheses
 - * title of the book, underlined; only the first word needs to have a capital letter
 - * city where published
 - * name of the publisher

authors	year	title	place	publisher
Kellogg, R.T.	(1994)	<u>The psychology of writing</u>	New York:	Oxford University Press
Barzun, J and Graff, H.F.	(1992)	<u>The modern researcher</u> 5 th edn	Orlando:	Harcourt Brace Jovanovich

Notes:

- * when there are more than three authors, generally only one is listed, followed by a comma and *et al.*

author	date	title	place	publisher
Brown, S., et al.	(1996)	<u>500 tips for research students</u>	London:	Kogan Paul

- * in your bibliography, if there are two or more works by the same author, they should be listed chronologically. If there are two by the same author in the same year, the date is followed by *a*, *b*, etc.

Fitzgerald, R. F.	(1989)	<u>Controlling oil spills</u>
Fitzgerald, R. F.	(1990a)	<u>Water purification systems</u>
Fitzgerald, R. F.	(1990b)	<u>Water waste today</u>

- **Reference to an article from a journal.** Information to include:
 - * name of the author(s)
 - * year of publication, in parentheses
 - * title of the article, without quotation marks or underlining, with only the first word capitalised
 - * name of the journal underlined, with all major words having a capital letter
 - * volume number, underlined
 - * inclusive page numbers, not preceded by *p* or *pp*.

author(s)	date	title	journal	volume	pages
Hartley, J.	(1991)	Tabling information	<u>American Psychologist</u>	<u>46,6:</u>	655-6
Eklundh, K.S.	(1994)	Linear and non-linear strategies in computer-based writing	<u>Computers and Composition</u>	<u>11:</u>	203-16

- **Reference to an unpublished work.** The information would appear as follows:

author	date (if known)	title	source / availability
Reese, R.A.	(unpublished)	Survey of postgraduate student writers' use of computer software.	Paper available from the author, Computer Centre, Hull University

- **Reference to material from electronic media and the Internet.** Information to include:

- * names of the author(s), if known
- * title of the extract
- * title of the complete work (if known), underlined
- * if **CD-ROM**, then: name of CD-ROM producer + publication date
- * if **Internet**, then: name of producer of online website
- * Internet address of the quoted material
- * date that the site was accessed online

author	title	producer	address	date accessed
Middlebury	<u>Citing electronic sources</u>	MLA	<http://www.middlebury.edu/~lib/citing.mla.html>	(July 1999)

2.10 Plagiarism

All academic, scientific, technical and research writing **must** document all sources used. If you purposely use another person's writing as if it was your own, then you are guilty of plagiarism, the literary form of theft. Not to cite a source used is a most serious offence and the integrity of the writer and the writer's work will be seriously compromised if not dismissed outright.

What sources must be documented?

- Every reference to another's work, word or ideas must be cited.
- Every paraphrase must acknowledge the original source.
- Every citation from a book, magazine, journal, the Internet, or speech must be noted.
- Every borrowing must be documented.
- Every quotation (whole or partial) must be given due credit.

Not all plagiarism is intentional, but that in no way changes the seriousness of the offence – and the consequences suffered in reputation and integrity for the writer, the writer's research, and the writer's written results. Plagiarism can and has destroyed careers.

What are the basic ways of avoiding plagiarism?

- provide in-text documentation for each idea you have 'borrowed' from someone else (see Section 4.8 *Quoting*)
- put quotation marks round each item directly quoted (see Section 4.8 *Quoting*)
- make sure that your paraphrased material is written in your own style and language, and not simply copied from another person, or their sentences just rearranged (see Section 4.7 *Paraphrasing*)
- provide detailed information in your footnotes (or endnotes) and bibliography about all the sources you have cited (see Section 2.9 *Referencing*)

2.11 Abstracts

Abstracts are called ‘summaries’ by some journals, though strictly speaking the terms are not exactly the same.

- A **summary** restates the main findings and conclusions of a paper and is written for people who have already read the whole thing. (See section 2.12 *Summary Writing*)
- An **abstract** is a shortened version of the paper written for people who may never read the full version. Since abstracts are often reprinted in abstracting journals separated from the original paper, they need to be self-explanatory.

An abstract normally appears at the top of the page in front of the actual paper it outlines. The purpose is to inform readers as concisely as possible what is in the article so that they can decide whether to read it in detail.

What types of abstracts are there?

There are two kinds of abstract –

- **Descriptive abstract:** this provides a kind of ‘contents list’ of what will be in the paper; what the writer will deal with or attempt to prove in the article, rather than a synopsis of the actual results. Since it contains general statements, it is more appropriate for longer papers, such as review articles, and can be written before the paper itself is drafted.
- **Informative abstract:** this does not simply describe what will be in the paper, but also gives a summary of the main factual information, such as your methods and materials, results and conclusions. This type of abstract is more suited to papers or reports about original research. It is usually better to write an informative abstract when the writing of the complete paper is finished.

Should I write a descriptive abstract or an informative abstract?

Your journal editor will guide you on this point. Normally, when writing up research, the informative abstract is better since you give the reader factual information as well as your main opinions. In some circumstances, the descriptive abstract is preferred, e.g. if you are working in a controversial area and have results that you do not want to reveal until the reader has read the whole paper. Abstracts can also be a mixture of both descriptive and informative elements.

How long should an abstract be?

There is no fixed length. It is important to write enough for what the reader needs to know rather than summarising everything in the paper. A typical length is between 100 and 250 words, or between 5% and 10% of the original.

What should an informative abstract contain?

The informative abstract will contain a selection of these elements, depending on how you perceive the reader's needs

- an expansion or explanation of the title
- the purpose of the research
- how the research was conducted
- what the main findings were
- what the findings mean
- what recommendations can be made, e.g. for further research
- what the limitations of the research were

Normally you would NOT include in your abstract

- any information that is not in the paper itself
- tables and diagrams
- citations from other people's work

How is an abstract structured?

Rather than following the sequence of sections in the paper itself, it is often a good idea in an abstract to put the most significant ideas first, whether it be the method, the results, your recommendations, or whatever. In this way, readers who are short of time will at least know your main point even if they only read the first sentence.

Is there any difference in style between a descriptive and an informative abstract?

Both types of abstract must communicate ideas effectively, preferably with direct, active statements in short, simple sentences. There can be a difference in the use of verb tenses:

* use the *present tense* when you make general statements of fact, or say what your paper does (as in a descriptive abstract)

* use the *past tense* when you explain what you actually did or found out in your piece of research (as in an informative abstract)

The descriptive abstract will make more use of generalised vocabulary and phrases, while the informative abstract will have more precise, specific language, including numbers.

What are 'keywords'?

These are the most important words in your paper that are specifically related to your topic. Your editor may want you to identify these so that they can be printed at the end of the abstract (or sometimes after the title in the journal's contents list).

Example abstracts

Abstract A

An Overview of Rotating Stall and Surge Control for Axial Flow Compressors.

Modeling and control for axial flow compression systems have received great attention in recent years. The objectives are to suppress rotating stall and surge, to extend the stable operating range of the compressor system, and to enlarge domains of attraction of stable equilibria using feedback control methods. The success of this research field will significantly improve compressor performance and thus future aeroengine performance. This paper surveys the research literature and summarizes the major developments in this active research field, focusing on the modeling and control perspectives to rotating stall and surge for axial flow compressors.

Keywords: axial flow compressor, rotating stall, surge

Gu G., Sparks A. & Banda S. *IEEE Transactions on Control Systems Technology* Vol 7 No 6 November 1999 p. 639-647.

Points to note

- **Purpose.** Abstract A is a descriptive abstract: it tells you what the writers do in the article, but not their actual ideas.
- **Structure.** 'A' begins with an explanation of the research field, its aims and the potential outcome of the research; it goes on to state the authors' intention of surveying the research literature and summarising major developments.
- **Language use.**
 - * It uses only present tenses (including present perfect and *will* future).
 - * It contains generalised academic phrases, e.g. *have received great attention, the objectives are to ..., this paper surveys ...and summarises ..., focusing on ...*
 - * Both abstracts use extended sentences in order to condense information. In 'A' we have *The objectives are to ..., to ..., and to ...*

Abstract B

CD46 is a Cellular Receptor for Human Herpesvirus 6

Human herpesvirus 6 (HHV-6) is the etiologic agent of exanthum subitum, causes opportunistic infections in immunocompromised patients, and has been implicated in multiple sclerosis and in the progression of AIDS. Here, we show that the two major HHV-6 subgroups (A and B) use human CD46 as a cellular receptor. Downregulation of surface CD46 was documented during the course of HHV-6 infection. Both acute infection and cell fusion mediated by HHV-6 were specifically inhibited by a monoclonal antibody to CD46; fusion was also blocked by soluble CD46. Nonhuman cells that were resistant to HHV-6 fusion and entry became susceptible upon expression of recombinant human CD46. The use of a ubiquitous immunoregulatory receptor opens novel perspectives for understanding the tropism and pathogenicity of HHV-6.

Santoro F., Kennedy P., Locatelli G., Maluati M., Berger E., Lusso P. *Cell* Vol 99 No 7 December 23, 1999

Points to note

- **Purpose.** Abstract B is an informative abstract: it contains details of what was investigated, what the findings were and what might happen in the future.
 - **Structure.** 'B' first defines HHV-6 and explains its importance; it gives the purpose of the research (*we show that ...*), the method (*Downregulation ...*) and the results; it concludes with a statement of future prospects as a result of the research.
- **Language use.**
 - * It uses present tenses for general statements and explanation of what the paper does.
 - * It uses past tenses to describe the procedure and results of the research.

- * It contains a greater density of technical, topic-related terms than the descriptive abstract, together with specific verbs to describe precisely what happened in the research (*inhibited, blocked, etc.*).
- * Note the use of the passive when describing the research.
*It also uses extended sentences in order to condense information. For example, the first sentence is *Human Herpesvirus 6 is ..., causes ..., and has been*

Points to check in your own writing

- *Do you need to write an informative or a descriptive abstract?*
- *Does your abstract give the reader a clear, straightforward idea of what your research is about?*
- *Does it contain the right amount and the right kind of information (depending on what type it is)?*
- *Is it the right length?*

2.12 Summary Writing

A summary is a condensation of the main ideas in an article or in a section of someone else's writing. A summary may stand alone, for example as a similar piece of writing to an abstract. Or it may simply form a section within a longer piece of your writing. The aim of a summary is to give your readers a clear, objective, accurate and balanced account of an article they may, or may not, have not read, and to put it into the context of your own work.

Summarising therefore is a skill that involves picking out the key ideas in someone else's writing and linking them up in your own words.

What is the difference between summarising and paraphrasing?

There are clear similarities between the two since both involve the re-writing of an author's ideas in your own words. (See Section 4.7 *Paraphrasing*) However, the main differences are:

- a summary is likely to be shorter. Whereas paraphrasing may involve keeping more or less to the same length as the original, a summary could be the reduction of a long paragraph to a sentence, an article to a paragraph or a book to a page.
- a summary will keep to the structure and content of the original more closely than a paraphrase. The latter is more likely to include your personal gloss or interpretation of the original; in a summary you should avoid adding extra information or ideas that are not actually in the text you have read.

When is summary writing useful?

Apart from the need to summarise other writers' ideas at particular points when writing a research paper, the skill is valuable in these situations:

- when reviewing an article or book
- when annotating a bibliography entry
- when preparing an abstract

In addition, of course, it is useful to develop the skill by keeping summary 'note cards' on other works that you read. In particular, this will help you to avoid plagiarism, since by writing from notes you will be presenting information in your own words.

Are there any guidelines for summary writing?

1. Read the whole of the original text quickly to gain an impression of its content and its relevance to your work
2. Highlight the main points as you read
3. Make notes of your own on these points
4. Put away the original and rewrite your notes in your own words in complete sentences
5. Begin your summary with a statement of the main idea at the start. Don't forget to include referencing of your source.
6. Using your notes, write out your subsidiary or supporting points in coherent, well-connected sentences
7. Re-read your work to check that you have included all the information that you need.

Sample summary

The main points in the text below can be written in a shorter, summary form for inclusion in your own writing. Points about the summary:

- it is about one third of the length of the original (88 words, compared to 273 in the original)
- the number of sentences has been reduced from 16 to 4
- the information has been compressed into these 4 sentences by
 - * cutting out less important information, e.g. examples
 - * reducing a whole clause or sentence to a phrase
 - * by using more subordinate clauses
 - * linking ideas by simple use of commas

Original text

Solar power is energy generated from the sun. Many electronic devices, such as watches and calculators, can use the sun's energy directly to provide the power they need. Light energy from the sun changes the electrical conducting properties of the silicon crystals, and a tiny electric current starts to flow. This system is called a solar cell. Although solar cells used on earth do not provide much power, satellites in space run on the same principle. They get many times more energy because they are closer to the sun. In the future, workers in space may build huge power stations from solar cells many kilometers wide. The electricity generated could be beamed down as microwaves and then converted back into electricity. Most of the solar power that we use today is based on a much simpler principle than the silicon solar cell. Solar panels on the roofs of houses heat water directly for bathing and central heating systems. The industrial version of the solar panel is the solar furnace, in which huge, curved solar panels, together with a system of mirrors, concentrate a large amount of solar energy onto a small area. The heat energy makes steam for generating electricity. Solar power is clean, renewable, non-polluting and does not damage the environment. It is potentially one of the more important sources of energy in the world. A major disadvantage of solar energy is that the amount of energy generated depends on the season, the part of the world and the weather on a particular day. Another disadvantage is that the raw materials for solar panels, such as glass and aluminium, are quite expensive.

from Dr Trisha Greenhalgh (1994) Environment Today Harlow, Longman

Sample summary

Dr Greenhalgh explains how solar power works in two ways. Light from the sun can generate a tiny current in silicon crystals, creating a solar cell, which is used to run space satellites and in the future could provide electricity from space power stations. Solar panels, or the larger industrial solar furnace, generate heat directly through concentrating solar energy in a small area. Solar power is renewable, non-polluting and potentially an important energy source, but its value is limited by weather, region and the cost of raw materials.

Points to check in your own writing

- *In my summary, is there a clear thesis statement (with the writer's main idea)?*
- *Does it give a reader who has not read the original a clear idea of what it said?*
- *Does it include the writer's other main supporting points? Have I cut out unnecessary detail and examples?*
- *Does the finished summary have the same balance of ideas as the original text?*
- *Is it written in simpler language than the original?*
- *Do the ideas in the summary flow logically and in grammatically well-linked sentences?*

Chapter 3

STYLE

When publishing in English you need to take account of the general rules which have become accepted as the norm in academic communication. In writing technical and scientific papers in particular, you should aim to achieve objectivity, clarity and precision. In addition, there are conventions governing the use of formal patterns, though the need to establish rapport with your audience and to make your writing reader-friendly has an influence on determining your selection of formal or informal language phrases.

This implies that there still is a certain amount of creative use of language in the dissemination of research information and that scientific writing does not simply follow a set of mechanical writing procedures for reporting results. The written text also reflects, though to a very limited extent, cultural and rhetorical assumptions about what is presented and how the material is organised.

3.1 Objectivity

Objectivity is generally governed by the research topic although obviously it is individuals who actually have to select, arrange and present their findings. Thus it is your task, as the writer, to deal with your topic in a fair, objective and responsible manner, keeping your personal feelings out of your writing.

From a language point of view, objectivity and a neutral approach (impersonal style) may be achieved by using the passive voice and by avoiding ambiguous statements. Avoidance of confusing metaphoric elements, use of precise and well-established technical terms may add to effective writing and help to produce explicitness of standard academic description.

Using the passive voice in impersonal writing

Scientific writing is usually done in an impersonal style. Information and facts are more important than personal opinions or attitudes. This style is also used to put a certain distance between the writer and the arguments proposed and thus makes them more objective.

Personal / informal	Impersonal / formal
<i>We can distinguish</i> limits to other technical systems by ...	Limits to other technical systems <i>can be distinguished</i> by...
In the present article <i>I want to</i> ...	The present article <i>is intended to</i> contribute...
<i>We tested</i> thirteen SGS models ...	Thirteen SGS models <i>were tested</i> ...
... and as a result <i>we selected</i> the superior variants	...and as a result, the superior variants <i>were selected</i> ...
<i>I assume</i> that ...	<i>It is assumed</i> that...
<i>The authors consider</i> these results to be ...	These results <i>are considered</i> to be...
<i>Because we want to</i> evaluate ...	<i>In order to</i> evaluate...
If there <i>aren't any</i> ...	If there <i>are no</i> ...

Precise references to data in tables, graphs and diagrams also lead to greater objectivity in research findings.

3.2 Clarity

Simplicity of text and of text composition are important prerequisites to readability. You should always try to write in a plain, clear and straightforward manner. Overlong sentences or lengthy chains of clauses and groups of words can easily prevent your reader from understanding what you want to say. As a rule, you should not add more than 2 to 3 clauses of any sort to form one sentence. Repeating words, signposting and using linking devices which help the reader to connect and relate information are useful ways of achieving clarity and readability.

Example paragraphs

1 The following overlong sentence is almost unintelligible:

Axis-boundary conditions for the SGS stresses in case of scale similarity and mixed-type models are specified in terms of GS velocities at the axis so as to be compatible in the statistical mean with expressions for the axis values of... following from the kinematics of homogeneous axisymmetric turbulences as well as from the statistically averaged dynamic equations for the GS velocity field taking into account statistically steady and homogeneous flow conditions.

This can be re-written, as below, in order to make the meaning clearer. The text is divided into three shorter sentences and linking words and phrases added.

Axis-boundary conditions for the SGS stresses in case of scale similarity and mixed-type models are specified in terms of GS velocities at the axis. *This is done so that* they are compatible in the statistical means...for the GS velocity field. Statistically steady and homogeneous flow conditions are *also* taken into account.

2 In the following paragraph, notice the use of the linking phrases, or semantic markers in italics, which have been used in order to shorten sentences and make them understood more easily, thus improving readability:

In the first of this two-paper sequence, a highly automated method for generating reduced-order dynamic macromodels for electrostatically MEMS devices was presented. *The approach* was to use selected linear elastic modes of the device as basic functions, and to express the kinetic and potential energy in terms of basis-function amplitudes and their time derivatives. *It was demonstrated* that this procedure could, indeed, be executed nearly automatically, requiring only a few inputs from the designer to select parameters for the macromodel. *However,* while the procedure works well for nonlinearities produced outside the electric body, such as the non-linear electrostatic force between the plates of a parallel-plate capacitor with one plate being flexible, it fails to capture the correct mechanical structural stiffness when the deflections become comparable to a typical thickness. *This effect* is generally referred to as...

Expressing your ideas concisely

Being concise in your writing means expressing your ideas in as few words as possible. This involves not repeating what you say, cutting out irrelevant details and avoiding redundancy, that is, the use of unnecessary words. If your sentences are too 'wordy', they are difficult for the reader to understand.

	'wordy' sentences	more concise sentences
	We continued our activities in the development of new protocols for group communication.	We have developed new protocols for group communications.
	The different materials that contribute to an environmental impact have quantitatively different potential environmental effects.	Different materials have different environmental impacts.

3.3 Formality

Academic writing follows certain rules of formality which non-native writers should not violate without very good reasons.

Contracted verb forms

These are the representations in writing of verb forms normal in speech; a letter in the verb has been omitted, as indicated by an apostrophe. These contractions should be avoided in academic writing.

	This is a problem of linear algebra which <i>won't</i> be discussed here.
	This is a problem of linear algebra which <i>will not</i> be discussed here.

It is true that nowadays contracted verb forms can be found in scientific publications as they are increasingly regarded as a way of producing informality, thus creating communication with the audience. However, as a general principle, contractions are still not acceptable in technical-scientific papers and should be written out in full.

Use of the first person pronoun

It is normal practice to avoid using the personal pronoun “I” in scientific articles. Instead, “we” or “the team” are preferred. Some kind of switching between the different forms may nevertheless be appropriate in order to make the reader more involved in the argumentation. The switch from “we” or impersonal forms to “I” may help to establish the sometimes more desirable informal relationship with the reader.

3.4 Hedging

What is hedging?

Hedging means not making blunt, absolute or categorical statements; it means avoiding over-generalisations; it means toning down the positiveness of your statements to allow for others to disagree with them.

Why is hedging important in scientific writing?

Authors of scientific articles generally write in an impersonal style in order to sound more objective and convincing. They also want to avoid showing their personal attitude to their subject or an over-strong commitment to a particular conclusion, so hedging what they say is a way of accomplishing this. It thus involves not expressing the truth of a claim too strongly. Too direct and straightforward argumentation may give the impression of over-confidence

and this could puzzle some readers, particularly British or Asian ones who may consider it offensive.

What techniques can I use for hedging?

In order to avoid overgeneralising (especially in experimental descriptions) or to avoid being too critical or direct, there are a number of hedging phrases and other techniques that can be used to help establish better communication and rapport with the reader. These hedging devices are found quite frequently in introductions and conclusions.

- **Use of first person pronouns**

It is best for writers to avoid describing their findings in the first person *I / me / my*, since normally these pronouns would only be used by famous and important researchers or representatives of schools. In general, structures with *we / us / our* are preferred. This also has a rhetorical function: it implies the inclusion of the author as a co-member of a group. Thus if you want to state whether you are able to present positive, successful results or not, you can say: *We do not yet know*

- **Using tentative verb forms**

Statements that are too direct or over-positive can be softened as in these examples:

Over-positive statement	Hedged statement
The investigations of the present work <i>contribute</i> to the model and filter components of LES...	The investigations of the present work <i>are intended as a contribution</i> to the model and filter components of LES...
We <i>propose</i> a methodological approach...	We <i>would therefore propose</i> ...
The use of equivalence factors for ecotoxic effect <i>should be rejected</i> ...	<i>It is better for</i> the use of equivalence factors for ecotoxic effect <i>to be avoided</i> ...
Different variants of the disposal structures <i>must</i> be transferred in computer-aided modes...	<i>It is recommended</i> that different variants of the disposal structures be transferred in computer-aided modes...

Particularly useful verbs for hedging are *seem to ... / appear to ... / tend to ...*, as in these phrases:

Our data <i>seem / appear to</i>	<i>demonstrate that ...</i>
	<i>indicate that ...</i>
	<i>suggest that ...</i>
	<i>imply that ...</i>
<i>Our data do not appear to confirm that ...</i>	
<i>Our data tend to support the hypothesis that ...</i>	

- **Using modal verbs**

Many modal verbs indicate tentativeness or a lack of certainty and can therefore be used to soften what you want to say. Particularly useful modal verbs for this are *can / could / may / might / would*.

Direct sentence	Hedged sentence
It <i>will be</i> of interest to compose ...	It <i>might be</i> of interest to compose...
These findings <i>suggest</i> the following interpretation...	These findings <i>would / might / could</i> suggest the following interpretation...
X <i>is</i> due to Y	X <i>might / could be</i> due to Y...
Our data <i>are</i> expected to show ...	Our data <i>would be</i> expected to show...
From these results we <i>conclude</i> ...	From these results we <i>may</i> conclude...
This assumption also <i>explains</i> why ...	This assumption <i>may</i> also help to explain why ...
The present model <i>is</i> particularly useful ..	The present model <i>should be</i> particularly useful...
Finally, the insecurities of the evaluation <i>have to</i> be discussed.	As a final step, the insecurities of the evaluation <i>will need to</i> be discussed.

- **Using adverbs**

Using certain adverbs of degree and attitudinal adverbs can be used to soften what you say. They are especially useful when making generalisations, circumventing giving exact numerical data (when necessary) or avoiding making a claim for absolute truth.

Looking for oval pieces from the past, we found a long list but *certainly* there are more examples...

Other modifying expressions:

a little, rather, somewhat, almost, nearly, quite, approximately, about

3.5 Signposting

A good style is characterised as plain, clear and straightforward. Research findings, ideas and arguments should be connected in such a way that readers may follow and can be convinced of the given argumentation. Signposting devices or discourse markers are used to provide the linking of sentences and the relationship between them.

- **Noun substitution**

A synonym, a more general term or a personal pronoun can be used to refer back to a previously mentioned noun, sentence or fact.

A highly automated method was presented *The approach* was to use....
Large-Eddy Simulation has developed... . *It* is gaining...

- **Addition**

When you want simply to add a point or idea to reinforce or support what you have already said, you can use these conjunctions, adverbs and phrases:

* *also, again, furthermore, moreover, too, in addition*
* *equally, likewise, similarly, correspondingly*

Example sentences:

In addition, the investigations of the present study provided guidelines...

Again, if there are no net forces on internal boundaries, it is possible to make constant terms in We. A, B and C cancel for these phases

Similarly, from the unit displacement in direction 2 and 3, we can get the corresponding forces.

▪ **Sequencing: referring backwards or forwards**

Time relationships may be signalled by various phrases and words, such as adjectives, adverbs and verbs or noun phrases. These can also be used to show the logical relationship between ideas or to connect what you are saying with something you said previously. Words and phrases include:

- * *so far, earlier, previous(ly), before that, until now, already, formerly*
- * *at present, presently, meanwhile, at this point*
- * *first of all, to begin with, to start with*
- * *secondly, then, next*
- * *finally, eventually, afterwards, later, above all, last but not least*

Example sentences:

Finally, conclusions are drawn...

Above all, however, models of this type are not...

We encounter *first* the problem of expressing the equations at the current or the relaxed configurations...

In the following I will assume that elastic strains are negligible...

▪ **Reformulation**

This is where you want to express an idea in a different way, either to reinforce its importance or to make something clearer. Sometimes you want to suggest an alternative to what you said before. Phrases you can use include:

- * *to put it simply, better, rather, that is to say*
- * *in other words, alternatively, again*

Example sentence:

In other words, regularly antisymmetric profiles with more than two layers behave essentially as a profile of equal thickness composed of an infinite number of layers, or *alternatively*, a homogenous profile.

▪ **Inference**

This indicates a deduction from what you implied in the previous sentence. You can use phrases like:

- * *otherwise, or else, that being so, in that case*

Example sentence:

It is necessary to heat the mixture to 85° *or else* the desired results will not be achieved.

▪ **Highlighting**

You can emphasise or pick out particular words, points or ideas by using the following phrases. See also Section 4.5 *Emphasising*.

- * *namely, particularly, specifically*
- * *especially, notably, mainly, mostly, chiefly*

Example sentence:

More specifically, the authors are interested in the propagation of fractures through bonded layered media.

▪ **Cause and effect**

Words and phrases for expressing cause and effect are necessary for linking the different parts of a text. They are used to establish a logical connection between facts. This connecting function may be expressed by conjunctions, adjectives, adverbs, verbs and/or nouns.

The most common phrases for introducing **cause** are:

- * *due to, owing to, because of, resulting from*
- * *be caused by, spark off, give rise to, provoke, generate, bring about, stem from, arise out of, originate from, result from, enable*
- * *cause of, reason for, purpose of, with the aim of*
- * *since, for, because*

Effect may be expressed by:

- * *hence, thus, consequently, as a consequence, as a result, therefore, that is why, eventually, so, finally*
- * *result in, lead to, produce*
- * *the result of, the consequence of*

Example sentences:

<i>Owing to</i> a shortage in food supply, large amounts of wheat had to be imported.
The accident <i>was caused by</i> the icy conditions and not by any technical defects.
This is done <i>so that</i> they are compatible in the statistical mean with expressions for the axis values of...
We <i>therefore</i> propose a methodological approach on the basis of ISO 14040 "Life Cycle Assessment".
<i>The result of</i> these calculations will be a balance sheet of mass and energy flows in tabular form.

▪ **Introducing a result**

Phrases for expressing result include:

- * *as a result, with the result that, so that, thus, therefore, consequently, as a consequence, hence, thereby, for this reason, because of this*

Example sentences:

...the fluid can cause additional spring forces *as a result of* compression and inertial forces...

Thus, a priori tests alone do not provide conclusive evaluation of a SGS model.

▪ **Contrasting ideas**

Useful phrases include the following. See also Section 4.3 *Comparing and Contrasting*

- * *although, despite, in spite of*
- * *but, however, nevertheless, nonetheless, yet*
- * *on the contrary, by comparison, by contrast, in contrast to, on the one hand...on the other hand*
- * *instead, alternatively, conversely, whereas*

Example sentences:

Motivated by the advantages and the adaptive potential of the dynamic modelling procedures *on the one hand* and by the problem of ...*on the other hand*, the present paper proposes...

Though this additional flow-dependent input is required, it is, *however*, available...

Despite some critical assessment of this testing methodology and *despite* the need for further research work...

The thickness shear motions are polarized in two orthogonal planes in this case so that the concept of generalized shear planes is not tested here. *Nevertheless*, the results provide a benchmark for comparison of profiles with the absence of polarized motions.

▪ **Marking transition to a new topic**

Useful phrases include:

- * *with reference to, with respect to, with regard to, as for*
- * *let us now turn to, it follows that*

Example sentences:

With respect to the base parametrizations three model types are included...

With regards to the spatial filters involved...

▪ **Generalising**

This sometimes involves summation, or the summing up of what has gone before. Phrases include the following. See also Section 4.6 *Generalising*.

- * *in general, on the whole, by and large, in total, as a rule, for the most part, broadly speaking, speaking generally, usually*
- * *altogether, overall, thus, obviously*

Example sentences:

On the whole, sharp-cut-off type filters turned out to be more problematic from a numerical point of view and inferior to top-hat-filters...

In total, in nearly every respect, the best a priori test of the model/filter combinations under study was established for model 8...

Obviously, the values of p and q, and consequently the form of the solutions, depend on the value of e, which is related to the material properties.

Chapter 4 LANGUAGE FUNCTIONS

4.1 Agreeing and Disagreeing

Agreeing and disagreeing are typical elements of spoken English but may also appear in scientific writing. When writers want to compare their findings with those of other scientists, they may have to express their agreement or disagreement. For example:

* These results *agree with* the findings of X's research ...

Other contexts in which phrases expressing agreement appear in scientific literature include making assumptions or conclusions.:

Assumption	It is <i>generally agreed</i> that ...
Conclusion	In the previous chapter, we <i>agreed to</i> ...

What language can I use to express agreement?

The following verbs and phrases express varying degrees of agreement. Verbs such as *agree* are normally used in the active form with a personal subject (except in the examples given above).

- * *We entirely agree with his views on ...*
- * *We are in complete agreement with ...*
- * *We would (strongly) endorse X's opinion on ...*
- * *Our findings support those of ...*
- * *We would agree with X in principle, but ...*
- * *By and large, we accept what X says, but ...*

How can I express disagreement

There are a variety of verbs and other phrases for expressing disagreement. In particular, some phrases are useful when **refuting**, or arguing against, another scholar's findings.

- * *We completely disagree with X on this point.*
- * *We are in total disagreement with ...*
- * *(Regretfully), we are unable to accept X's conclusion that ...*
- * *We are not at all convinced by X's argument that ...*
- * *We have to say that X's argument is somewhat unconvincing.*

Some linking phrases for **contradicting** what someone else has written:

- * *In actual fact, ...*
- * *In point of fact, ...*
- * *On the contrary, ...*

Here are some phrases for expressing **partial** or **tentative disagreement**:

- * *We agree with X's findings up to a point, but ...*
- * *X may be right in certain respects, but our findings show that ...*
- * *We respect X's work in this area, but our initial conclusions indicate that ...*

4.2 Classifying

Classifying means allocating an object or term to a class of objects or terms which has already been established. The items to be classified are first considered with respect to an essential feature, then compared, and finally grouped in a class according to their respective similarities and differences.

What are the elements in a classification model?

The classification model consists of these elements. Note that the feature used for classification may, or may not, be actually named in the final description.

	Elements in the model	Example
1	the superordinate term (the overall word that includes all the others)	low-carbon sheets and strip
2	the feature used for classification	(size)
3	the items grouped together in a class	The light gages of low-carbon flat-rolled steel products <i>are classified as</i> hot-rolled sheets, cold-rolled sheets, hot-rolled strip, and the still lighter gages as tin mill black plate.

What language can be used in classifications?

- The following prepositional phrases are very useful when talking about the feature used for classification (item 2 above):

<i>xxx can be classified</i>	<i>by</i>	size
	<i>according to</i>	weight
	<i>according to whether</i>	composition
	<i>on the basis of</i>	etc.
	<i>with respect to</i>	
	<i>with regard to</i>	

- The following sentence patterns can be used to explain the way in which something can be classified:

A ... (superordinate term)	<i>is can be may be</i>	<i>grouped</i>	<i>commercially technically electrically ...</i>	<i>into</i>	... (nouns indicating the subordinated categories)
		<i>divided</i>		<i>into</i>	
		<i>classified</i>		<i>as</i>	
		<i>made</i>		<i>up of</i>	
		<i>broken down</i>		<i>into</i>	

A ... (superordinate term)	<i>is can be may be</i>	<i>classified grouped</i>	<i>electrically technically ...</i>	<i>as</i>	..., ..., ..., (nouns indicating the subordinated categories)	<i>according to on the basis of</i>	... (feature used for classification)
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For example:

Classification of cast steels

Commercially, steel castings are classified as follows:

- (a) low-carbon steels (carbon content below 0.20)
- (b) medium-carbon steels (carbon content between 0.20 and 0.50%)

....

4.3 Comparing and Contrasting

Comparing means putting two or more objects, facts or ideas together and stating in what ways they are similar or dissimilar. The two phenomena must be comparable, that is, they must have some characteristics in common.

Comparing two things is a fairly simple logical operation. Nevertheless, there is a wide variety of phrases and sentence structures that can be used to express different kinds of comparison.

In what different ways can things be compared?

▪ Similarity

When you want to emphasise the similarity between two things, you can use the following sentence patterns:

A	is are should be	<i>(about / almost / roughly / essentially the same as</i>	B
		<i>similar to</i>	
		<i>like</i>	
		<i>equal to</i>	
		<i>no different from</i>	
	<i>can be</i>	<i>compared directly to</i>	
A and B	are	<i>identical</i>	<i>in every respect</i>
		<i>the same</i>	<i>in most respects</i>
		<i>alike</i>	<i>in that ...</i>
		<i>similar</i>	

Some example sentences

- * The characteristic feature of the totality of natural numbers, ..., *is logically equivalent to* the principle of mathematical induction.
- * A point set in S in the plane is called bounded if For a point set in space the definition *is similar*, we
- * *By way of analogy*, the ALU may be thought of as a super adding-machine.
- * We define an accumulation point of S *in exactly the same way as* we did for point set on the line.
- * Sweden, *like* Finland, has very large resources of timber.

The following linking words and phrases may also be used to express similarity:

like ...; as well as ...; both ... and ...; just as ...;
In the same way, ...
Similarly, ...

▪ Dissimilarity

Dissimilarity basically means that one phenomenon is either *more* or *less* than another in one or several respects. The following structures can be used:

A	is	(much) (far) (substantially) (somewhat) (rather) (slightly)	adjective + -er more + adjective less + adjective	than	B
	is not	(almost) (quite)	as + adjective so + adjective	as	

Example sentence:

So even though it's non-porous, *much thicker* and *far more reliable than* gold plating, we can almost always offer our glad connectors for *less than* you would pay for an ordinary connector. In general, the dependence of the open-loop gain on temperature is *of less importance than* the thermal behaviour of the amplifier frequency response.

▪ **Superiority and inferiority**

This means saying how something is better or worse than something else, with regard to particular features. Phrases you can use include:

A	is	<i>superior to</i> <i>inferior to</i>	B	<i>in a certain way</i> <i>from a certain point of view</i> <i>with regard to ...</i> <i>as regards ...</i>	
				<i>in being</i> <i>in that it is</i> <i>inasmuch as it is</i>	<i>more + adjective</i> <i>less + adjective</i>
				<i>in</i>	<i>giving</i> <i>showing</i> <i>exhibiting</i>

Example sentences:

- * The reciprocating pump *is superior to* the rotary pump in being more efficient.
- * The yarn strength of air-vortex spun yarns *is somewhat inferior to* that of rotor-spun yarns, a 5% difference in strength being reported.

▪ **Proportionality and disproportionality**

When two objects, X and Y, are considered in relation to each other, the variability of certain of their features or characteristics can be compared. The comparison may produce either a proportional or a disproportional result. You can use the following sentence structures:

A feature of X	<i>changes</i> <i>varies</i>	<i>(inversely)</i>	<i>with</i> <i>as</i> <i>according to</i> <i>in accordance with</i>	<i>(a change in)</i> <i>(a variation in)</i>	a feature of Y
	<i>is</i>		<i>proportional to</i>		

As	a feature of X	<i>changes,</i> <i>varies,</i>	<i>so does</i>	a feature of Y	+ verb
<i>The (better)</i>			<i>so</i> <i>the (better)</i>		

Example sentences:

- * *The higher* the velocity of steam, *the greater* the turbine speed.
- * Data input rise and fall times *reduce as* driver output impedance increases.
- * The critical twist value, after which strength decreases, is lower for the former, but *increases with increasing* yarn linear density, which is the reverse of the effect found for conventional yarns.
- * During expansion, the pressure *varies inversely to* the volume.

▪ Contrasting

Contrasting is a specific kind of comparison. Whereas in comparing you normally look for at least one feature that the two or more objects have in common, in contrasting you aim to identify the differences between them.

Here are some useful sentence structures:

<i>It is</i>	<i>common useful valuable</i>	<i>to distinguish to differentiate to make a distinction</i>	<i>between A and B</i>
--------------	---------------------------------------	--	------------------------

A	<i>differs from is different from</i>	B	<i>in a certain respect in the fact that ... in that it is ...</i>
	<i>can be distinguished from</i>		<i>by its ... (a certain characteristic)</i>

<i>Unlike In contrast to As opposed to As distinct from As against</i>	<i>B,</i>	<i>A</i>	<i>is + adjective has + noun</i>
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Some common conjunctions and sentence linkers for expressing contrast:

<i>While ..., ... Whereas ..., ... On the other hand, ...</i>

Example sentences:

- | |
|---|
| <ul style="list-style-type: none"> * The RAM <i>differs from</i> the ROM <i>in that</i> it can be written into as well as read from. * <i>It is useful to differentiate between</i> a blower and a liquid. * The engine, <i>as distinct from</i> the earlier one, has six cylinders. * <i>Unlike</i> discrete-component designs, however, the microprocessor is not programmed using ... * These differences are ascribed to the fact ... most fibres have both ends spun in, <i>whereas</i> in the case of ring-spun yarns one fibre end frequently protrudes from the yarn. * A hot engine will run on a weak mixture. <i>On the other hand</i>, a cold engine requires a richer mixture. |
|---|

4.4 Defining

In science and technology, there are generally two kinds of definitions:

- the **real definition**, that is a definition that explains precisely the essential, intrinsic characteristics of an object.
- the **nominal definition**, that is one that helps to determine the meaning of a term, such as a word, sentence or symbol, e.g. in a mathematical language.

What language can I use for real definitions?

Real definitions include these functions:

- **Defining an object**

A	is is equal to equals is equivalent to corresponds to is said to be may be said to be	B = (noun with attribute) (noun without attribute) (noun + genitive) (noun + preposition + object)
By A	is meant we mean	

Example sentences:

- | |
|--|
| <ul style="list-style-type: none"> * Geometry <i>may be said to be</i> a study of the properties of geometric figures. * By a set of real numbers <i>we mean</i> an aggregate or class of numbers. |
|--|

- **Defining an object by assigning it to a category and specifying it**

A	is		B + specification: (relative clause) (prepositional phrase) (to + infinitive) participle clause (-ing / -ed) participle clause + to infinitive / for + gerund
	is may be	called termed thought of as referred to as defined as	
By A	is meant we mean		

Example sentences:

- | |
|---|
| <ul style="list-style-type: none"> * A pyrometer <i>is</i> an instrument <i>for measuring</i> high temperatures. * Milling <i>is</i> a machining process <i>in which</i> a rotary cutter equipped with a number of teeth <i>is rotated rapidly</i> while the work is fed under it. * Roughly speaking, a surface <i>is</i> a configuration of points <i>having</i> a two-dimensional character. * Brittleness <i>may be defined as</i> the absence of the ability to deform plastically. * A key <i>is</i> the information <i>required to locate</i> a record within a DASD file declared with the attribute DIRECT. |
|---|

What language can I use for nominal definitions?

Here are some of the sentence patterns you can use:

If A satisfies certain conditions	then it is then it can be	said to be called referred to as expressed as expressed in the form of termed	Z
	then we call it		

A	<i>defined by ... determined by ...</i>	<i>is called is said to be is expressed as is expressed in the form of is termed</i>	Z
---	---	--	---

Example sentences:

- * A curve *is called* smooth if two conditions are satisfied: (1) (2)
- * A function $f(s)$ *defined by* $f(s) = f \dots\dots$ *is called* the Laplace transform of the function $f(t)$.
- * The *term* computer normally *refers to* a general-purpose, high-speed, programmable machine that is designed to handle a wide range of computer problems.

4.5 Emphasising

In your writing you will be making statements that vary in importance. You will therefore need to make sure that the most important ones are given more emphasis than the less important ones. Details in your argument have to be presented in such a way that readers understand their relative significance.

How can I emphasise points visually?

- make use of tables, graphs, charts and other visual forms of illustration in support of your written text. It is easier for many readers to extract information from a diagram than to follow the detail of your written argument. However, you should realise that the more tables you include, the less will be the impact of each.
- visually, text that has white space around it stands out more than something that is surrounded by a lot of other text. Therefore
 - * make use of headings, separated from the body of writing
 - * occasionally break up your paragraph into bullet points. (Though this should not be overused, except perhaps in a report where it is more acceptable)

Gallium arsenide is a remarkable material with a battery of useful qualities:

- It moves electrons around three to six times faster than silicon.
- It emits light - something silicon cannot do.
- It absorbs sunlight more efficiently than silicon, making possible better solar cells
- It uses less power than silicon.

- * make sure you put the main idea at the start or at the end of your paragraph so that its importance is not concealed by other sentences around it
- * vary the length of your sentences, and of your paragraphs. In particular, sentences or paragraphs that are shorter than the norm do stand out.

How can I use language to emphasise points?

In spoken English, you can emphasise parts of a sentence simply by using stress on important words. In writing, of course, we cannot do this. Instead, we can emphasise particular words or phrases by putting everything into a kind of relative clause except the words we want to emphasise. These structures are called **cleft sentences**.

- *It was ...who / that ...*

Röntgen discovered X-Rays in 1895. <i>(no emphasis)</i>
It was Röntgen who discovered X-Rays in 1895. <i>(emphasis on the person)</i>
It was in 1895 that Röntgen discovered X-Rays. <i>(emphasis on the date)</i>
It was not until 1895 that Röntgen discovered X-Rays. <i>(emphasis on the fact that it wasn't earlier than this)</i>
It was X-Rays that Röntgen discovered in 1895. <i>(emphasis on what Röntgen discovered)</i>

Other cleft sentence structures:

- *What ... was ...*
- *The reason why ... is that ...*

no emphasis	emphasis
Einstein showed that space-time and gravitational forces are profoundly related.	<i>What Einstein showed was that space-time and gravitational forces are profoundly related.</i>
The southern hemisphere shows little response to eruptions in the north because it is dominated by oceans that damp down any change.	<i>The reason why the southern hemisphere shows little response to eruptions in the north is that it is dominated by oceans that damp down any change.</i>

You can draw attention to the new information that you want to present by changing the sequence of the parts of a sentence, using such structural forms as:

- *One / The only ... is / was ...*

<i>One erasable system that is being considered by developers like IBM and 3M is a technology called magneto-optic recording.</i>
<i>The only time this effect has been reported was in 1995.</i>

You can add emphasis by starting your sentence with a negative expression or one including *only*. Note that with these structures the subject and the main verb in the sentence have to be inverted, or changed round.

- negative expressions such as *Never..., Seldom..., Rarely...; Under no circumstances..., At no time..., In no way...*

no emphasis	emphasis
He did not allow his assistants to be absent under any circumstances.	<i>Under no circumstances did he allow his assistants to be absent.</i>
He had never managed to use his deductive skills so well as in this experiment.	<i>Never had he managed to use his deductive skills so well as in this experiment</i>
We will know the next steps to take when the report has been carefully analysed.	<i>Only when the report has been carefully analysed will we know the next steps to take.</i>
Scientists have recently discovered a cure for certain types of leukemia.	<i>Only recently have scientists discovered a cure for certain types of leukemia.</i>

You can also add emphasis by using balancing or parallel structures in a sentence, e.g. *not only ... but (also) ...; just as ... so ...*

<i>Not only was Röntgen's discovery of X-Rays important in itself, but it led directly to the discovery of radioactivity.</i>
<i>Just as Avogadro saved his idea that equal volumes of gases contain equal numbers of molecules by introducing a new idea, so Kekulé rescued his idea that carbon is tetravalent by inventing the carbon-carbon bond.</i>

Points to check in your writing

- *Have I given the right degree of emphasis to my important points?*
- *If not, how can I highlight them better?*
- *Can I make more, or better, use of visual techniques to make important points stand out?*
e.g.
 - * *tables, charts, graphs*
 - * *page layout*
 - * *using bullet points*
 - * *positioning ideas in paragraphs*
- *Do I need to change the grammatical structure of sentences to give more emphasis to important points?*

4.6 Generalising

Your writing will probably consist of a mixture of both *general* statements and *specific* statements and it is important to distinguish between the two. Generalising means making an overall statement, for example in the form of a conclusion, on the basis of supporting statements that provide the details or the evidence.

Are there any generalisations I should avoid?

Yes. For example:

- the 'sweeping' over-generalisation, in which you say something is true in every situation. Your statement may have some element of truth but cannot be treated as valid because there are so many exceptions and it is unsupported by evidence.

Boys are better at science at school than girls.

- expressing your own viewpoint as if it were a generally accepted truth

X is obviously the most highly regarded physicist of his generation.

- making non-statements that are either so obvious that they need not be stated or so vague that they have no real meaning.

After recognising problems with the solar mirrors, we carried out some corrective procedures.

If this sentence stands alone without supporting information, it is far too general. It raises more questions than it answers: *What were the problems with the mirrors? How many mirrors were involved? What precisely were the corrective procedures taken?*

How should I make use of general statements in my writing?

- Your main, or 'topic', sentence in a paragraph is often a general statement which is then explained, amplified, supported, exemplified or modified in the rest of the paragraph. The first sentence in the paragraph below is a general statement round which the rest of the paragraph is structured. See also Section 2.3 *Paragraph Writing*.

Industry produces a large number of poisonous metal wastes, most of which are very dangerous to humans. There are five extremely dangerous ones: lead, cadmium, mercury, chromium and arsenic. Breathing in even tiny quantities of these metals damages the heart and lungs; and eating these wastes destroys the kidneys and liver. Scientists also claim that cancer is caused by some of these toxic metals.

- When describing information in a figure, e.g. how something operates, the principal, or generalised, point you want to make can appear in your main text, with subsidiary information given under the figure.

Blackett made the cloud chamber more effective for cosmic rays by combining it with counters (Fig. 3.21). Only when the counters fired was an expansion made and stereoscopic photographs taken, thus enormously reducing the waste of plates and time in scanning them.

(This text is accompanied by a labelled diagram. The text under the diagram explains how each part of the cloud chamber operates)

- Similarly, when describing data in a graph or chart, the primary facts you want to highlight can be presented in the form of general statements in your text, with the detail merely left visible on the graph itself.

Fig. 7.1 illustrates how the growth in population in the US has been accompanied by a trend to urbanisation.

(This text accompanies a graph with 2 axes, one showing a time scale, the other the % of US population living in cities)

What language can I use when making general statements?

The main principle is to tone down your statements, make them less absolute. For more ideas about this, see hedging.

- verbs and verb phrases

- * *tend (not) to ..., have a tendency to ...*
- * *be inclined to ...*
- * *seem to ..., appear to ...*
- * *It appears / seems to / that ...*
- * *It would seem / appear to / that ...*

- adverbs of frequency: avoid absolutes like *always / never*

- * *usually, normally, generally*
- * *regularly, often, frequently*
- * *sometimes, occasionally, at times, now and again*
- * *rarely, seldom, hardly ever*

- modifying adverbs

- * *mainly, primarily, principally, chiefly, above all, overall*
- * *in general, on the whole, as a rule, largely*
- * *for the most part, mostly*
- * *especially, particularly, notably*
- * *clearly, obviously, evidently, distinctly, plainly, noticeably*
- * *significantly*
- * *relatively, comparatively*
- * *somewhat, rather, fairly, quite*
- * *slightly*

Points to check in your own writing

- *Have I made any sweeping or over-generalisations that I need to cut out?*
- *Are all my general statements, e.g. 'topic' sentences in paragraphs or conclusion, backed up the right evidence and examples?*
- *Have I used the right hedging language to give the tone I want to my general statements?*

4.7 Paraphrasing

Paraphrasing means expressing the thought, meaning and attitude of another author in your own words, in a clear and straightforward way. It is therefore similar to quoting, but it is done indirectly, without using the original writer's actual words or speech marks. With paraphrasing, you avoid continuous strings of direct quotations and are able to maintain your own style and tone of writing. However, as with direct quoting, it is essential that you do proper referencing for all your paraphrases.

With a paraphrase, your aim is to relate what the author has said to your own piece of work, and this often requires you to provide an interpretation, or gloss, on their ideas in some way, to make them fit into your argument. A paraphrase is not just a simple re-wording of the original.

How long should a paraphrase be?

- There is no set length, as it depends on how much of a writer's work you want to refer to, and in how much detail. In some cases, paraphrasing may simply involve reducing, or summarising, what the original writer has said into a single sentence:

The first published professional response to ape language studies was an article by Jacob Bronowski and Ursula Bellugi (1970). They argued that although chimpanzees might be able to use reference, they could not break grammatical units down to their units and recombine them (a process they called 'reconstitution').

- It may give a more detailed description of a writer's argument, consisting of a paragraph or more:

Levins (1968) used fitness sets to identify the optimal genetic strategy in response to environmental variation. The optimal genetic strategy is not determined solely by the nature of the environmental heterogeneity but partly by the perception of that heterogeneity. For example, it is very unlikely that The general conclusion of these analyses of fitness sets was that fine-grained species would evolve a strategy of monomorphism, whereas coarse-grained species would maintain polymorphism.

(Note: for brevity, the dots indicate that 5 sentences are omitted; these provide the detail of the writer's argument.)

- You may want to give your opinion, or commentary, on the writer's ideas at the same time as paraphrasing them:

When Freud begins to discuss 'lapses of memory' in terms of repression, he seems to move on less firm ground. He does not, of course, claim that all lapses are due to repression. His concern is to show that at least some are and, to this end, he gives examples in which a name or a word is unexpectedly forgotten and proceeds to demonstrate that the forgotten item is associated either directly or indirectly with unpleasant circumstances. Here we may cite two of his most convincing examples

What language changes do I make when paraphrasing?

- **vocabulary.**
 - * keep the specialised terms that are related to the topic, or those for which there are no synonyms, e.g. *calcium*, *neutron*, *protein*
 - * do not change proper nouns (e.g. names of countries and organisations), numbers, formulae
 - * for the rest of your text, use different vocabulary whenever possible, especially simpler phrases and more common synonyms and expressions. Using your own words makes your paraphrase fit in with the style of the rest of your text.
- **grammar**
 - * the grammar of the original needs to be changed, so that the points you are reporting on fit in with the grammatical flow of your text
 - * if your paraphrase is summarising and thus shortening the original, this will involve reducing perhaps 3 or 4 sentences (or more) down to one. This will require you to use a variety of subordinate clauses and adverbial or participle phrases.

How do I do in-text referencing?

The same guidelines described in Section 4.8 on *Quoting* apply to paraphrasing.

Language to use to introduce paraphrases

- You can use the same 'reporting' verbs for paraphrasing as are given in Section 4.8 on *Quoting*. In particular, verbs that reflect the original writer's purpose or attitude towards his/her subject are useful when paraphrasing, e.g.

X identifies ... as ...
X defends his position by arguing that
X attacks his opponents with his statement that ...
X affirms his opinion that ...

- Note that the 'reporting' verb can be followed by *that* ... (or this can be omitted).
Punctuation: there is no comma before or after *that*:

Fred Hein explains that each person's heredity is unique, except for identical twins.

- The normal grammatical rules for writing indirect speech apply:
 - * When the reporting verb is in the past tense, the verb tense in the reported clause, together with pronouns and time phrases may also have to be changed to indicate the correct time references.

MacSpratt (6) found that when sheep were deficient in nitrogen, the rate of mitosis in wool follicles was 63% of normal and concluded that nitrogen is essential to normal growth of wool.

Note that the last verb *is* is in the present tense: this is because the writer is generalising, or making a conclusion about what he regards as a general truth. If the writer knows that later work found this conclusion to be false, he would use *was* instead.

- You can also use the other introductory phrases given in the section on quoting. These in fact are more commonly used with indirect quotations than with direct ones.

- With indirect quotations, you can also simply put the name of the source at the end of the paraphrase, without any 'reporting' verb or introductory phrase:

Changes in the surface heating of the earth will result in changes in the heating of the atmosphere which in turn can affect the climate (Cohen, 1994).

Points to check in your own writing

- *Are all my paraphrases relevant?*
- *Have I paraphrased the points from my sources accurately?*
- *Are my paraphrases of the right length? (not too short, not too long)*
- *Have I added my own opinion to the paraphrases? If so, have I made it clear what are the original writer's points and what are mine?*
- *Have I structured my paraphrases grammatically into my text, so as to maintain a natural and logical flow?*
- *Are they all properly referenced?*

4.8 Quoting

When writing a research paper or report, it is normal to include references and quotations from the work of others. This is for one or more of the following reasons:

- to cite evidence or opinions from an authority on the subject in support of your argument
- to put forward someone else's viewpoint that you intend to argue against
- to show the range of source materials you have used to support or challenge your own ideas
- to acknowledge that your arguments derive from the work of others and thereby put them into their academic context

What kinds of quotation are there?

Quotations in your text can either be

- **direct:** that is, you use the actual words of the original writer, or
- **indirect:** that is, you paraphrase what the original source says by putting the ideas in your own words.

In general, it is preferable to use the indirect, or paraphrasing, method since this incorporates the other author's ideas better into the flow of your own text. However, there are occasions when direct quotations are better:

- when the author expresses an idea in a particularly succinct or memorable way that it is impossible to improve on it
- when the writer is such an important authority on the subject that his/her actual words are significant
- when you want to avoid any ambiguity about the quoted ideas

How long should direct quotations be?

In principle, you should keep quotations as brief as is necessary for them to make their point. Avoid using long quotations in case they detract from your own argument; only quote longer passages if you intend to analyse the writer's argument in detail.

How should I punctuate quotations?

- if your quotation is short, maybe only two or three words, try to run it within the grammatical flow of your sentence. This means single quotation marks are sufficient (together with appropriate referencing)

The conclusion of their analysis is that commercial nodule mining is unlikely for 'the foreseeable future' (35).

- if your quotation is a little longer and is preceded by an introductory phrase, then you can use a comma or a colon before the quotation itself.

In one of his many publications concerning the role of science, Freeman wrote: 'Much scientific research is concerned with the exploration of the unknown. By definition we cannot know the outcome of such explorations and still less can we know its future impact on technology.' (39)

- most importantly, you must make sure you keep grammatical and logical cohesion between the quotation and your own text. To do this, you may have to add or delete words from the original, though you should keep these changes as small as possible. Where you add words, put square brackets round them.

According to popular view of evolution, even after Darwin, 'each [species] could realise its inner potential, which gradually unfolded.' (Kuper, 1985, p. 4)

- if you omit some of the author's original words which are not relevant to your purpose, use three dots (...) to show where you have left the words out.

Case argued that the stage concept is valid: '... children go through the same sequence of substages across a wide variety of content domains, and ... they do so at the same rate, and during the same age range.' (Case, 1985, p.231)

- if the quotation contains another quotation, then use single quotation marks ('...') for your quotation and double quotation marks for the author's quotation ("...").

A New Scientist survey of 1982 concluded that this was 'in accord with the ideas expressed by C. P. Snow (1964) when he spoke of "the gulf of mutual incomprehension that lies between the literary and scientific worlds".' (3)

- if your quotation is long, say, more than three lines, then it should be indented as a separate paragraph. In this case, there are no quotation marks at all.

James (1983) devoted a whole chapter to instinct. He began with the following statement:

Instinct is usually defined as the faculty of acting in such a way as to produce certain ends, without foresight of the ends, and without previous education in the performance They are functional correlates of structure. With the presence of a certain organ goes, one may say, almost always a native aptitude for its use. (p. 1004)

How do I do in-text referencing?

There are two ways in which an author can be cited, and you will need to check with your publisher which one to use:

- the *name and year* system: used mainly in biological and earth sciences, as well as the social sciences, education, linguistics.
- the *number* system: used in the applied sciences, such as chemistry, computer science, engineering, mathematics, physics and medicine.

The name and year system. Place the year in brackets immediately after the author's name. Add the page number reference, if needed, at the end of the sentence, again in brackets.

Jones(1992) found that 'these data of psychological development suggest that retarded adolescents are atypical in maturational growth.' (p.215)

The number system. Place the number in brackets immediately after the author's name when it occurs, or alone at the end of the sentence. The numbers you give to your citations refer to your list of references at the end of your work, and these can be arranged either alphabetically (by author) or consecutively as they appear in the text. You can add a page number reference too, if you want.

Kanner (1, p. 249) labelled the disorder as 'early infantile autism'.

All in-text citations, either name-and-year or number, must of course refer to your list of references at the end of your work.

Language to use to introduce quotations

- There are a wide variety of 'reporting' verbs and verb phrases that you can use to introduce a quotation. Here are some of the more common ones

<i>acknowledge ...</i>	<i>admit ...</i>	<i>allege ...</i>	<i>argue ...</i>
<i>assert ...</i>	<i>assume ...</i>	<i>believe ...</i>	<i>claim ...</i>
<i>conclude ...</i>	<i>contend ...</i>	<i>demonstrate ...</i>	<i>describe ...</i>
<i>emphasise</i>	<i>explain ...</i>	<i>imply ...</i>	<i>indicate ...</i>
<i>make the point ...</i>	<i>observe ...</i>	<i>point out ...</i>	<i>postulate ...</i>
<i>predict ...</i>	<i>propose ...</i>	<i>prove ...</i>	<i>report ...</i>
<i>say ...</i>	<i>show ...</i>	<i>state ...</i>	<i>suggest ...</i>
<i>think ...</i>	<i>write</i>		

Be careful about the verb tenses of these verbs:

- * If you use **MLA Style**, you should put the verbs in the present tense both for personal comments and for quotations.
- * If you use **APA style** (more common for the natural sciences), you should put the verbs in the past tense for citations, and only use the present tense for generalisations and statements about unchanging facts. (See the example quotations above).

- You can introduce your citation with any of these longer phrases:

According to X, ...
As X has shown, ...
For X, ...
In X's view, ...
By this, X meant ...
X was of the opinion that ...
X distinguished between ... and ...
X characterised / considered / defined / recognised / referred to / regarded ... as ...
X illustrated his / her argument by saying / stating / showing that ...
X laid particular emphasis on ...
X makes the following claim / point / statement: ...
X put forward the theory that ...
Referring to ..., X said / stated / showed ...

Points to check in your own writing

- *How many quotations have I used?*
- *Would indirect quotation (paraphrase) be better than direct quotation in some cases?*
- *How long are my quotations?*
- *Are all my quotations relevant?*
- *Are they all well structured grammatically into the sentence?*
- *Is the punctuation accurate?*
- *Are they all properly referenced?*

Chapter 5

GRAMMAR

5.1 Adverbs

Adverbs are words that modify the meaning of another word or even a whole sentence. They do this by providing an answer to such questions as *How ...? To what extent...? Where...? When...? How often ...? and In what manner ...?*

A <i>slightly</i> non-planar crack is treated as being perturbed from <i>perfectly</i> planar reference crack.	<i>To what extent...?</i>
The perturbation method we develop <i>here</i> applies to any crack geometries	<i>Where ...?</i>
<i>Finally</i> , the normalised dynamic stress intensity factors are presented in Figs.10 and 11.	<i>When...?</i>
<i>Independently</i> , using the same class as for material 1, we apply a different linear combination of all the nuclei of strain at the object point of material 2.	<i>In what manner...?</i>

Which other words can adverbs modify?

They can modify:

- **verbs**

Magnesium is a metal which burns *brightly*.

- **adjectives**

This results in *very* large systems of equations due to the need to extend the discretisation well away from the zone of interest.

- **other adverbs**

This results in very large systems of equations due to the need to extend the discretisation *well* away from the zone of interest.

- **a whole sentence**

Conversely, when the second material is softer than the one containing the fracture, it attracts the fracture towards the interface in the same manner the stiffer material drove it away.

How are adverbs formed?

We can distinguish three types of adverbs:

simple	<i>just, only, well, back, out, etc.</i>
compound	<i>therefore, hereby, herewith, etc.</i>
derivational (mostly derived from adjectives with <i>-ly</i>)	<i>equally, finally, markedly sideways, clockwise, northwards</i>

Adjectives ending in both *-ic* and *-ical* have adverbs ending in *-ically*. The exception is *public* (adverb: *publicly*).

adjective	<i>academic</i>	<i>chemical</i>	<i>geometric, geometrical</i>	<i>electric, electrical*</i>	<i>economic, economical*</i>
adverb	<i>academically</i>	<i>chemically</i>	<i>geometrically</i>	<i>electrically</i>	<i>economically</i>

- * The adjectives with asterisks have different meanings:
 - *electric*: used with names of particular machines, e.g. *electric motor, electric blanket*
 - *electrical*: used before more general words, e.g. *electrical appliances, electrical engineering*
 - *economic*: refers to the science of economics or the economy of a country, e.g. *economic theory, economic problems*
 - *economical*: means 'not wasting money', e.g. *an economical car* (= cheap to run)

What are the problem areas when using adverbs?

■ confusing adjectives and adverbs

Adjectives and adverbs can express the same idea, but whereas you use an adverb to modify a verb or adjective, adjectives can only be applied to nouns.

adjective	adverb
Platinum has <i>exceptional</i> resistance to corrosion.	Platinum is <i>exceptionally</i> corrosion-resistant.
Iron is <i>easy</i> to extract from iron ores. / It is <i>easy</i> to extract from iron ores.	Iron can <i>easily</i> be extracted from iron ores.

■ position of the adverb in the sentence

Adverbs can be placed at the beginning, in the middle or at the end of a sentence, but the rules are complex. See Section 5.7 *Word Order* for more details.

■ using adverbs as sentence modifiers

In academic writing, adverbs and adverbial phrases are frequently used as sentence modifiers. When they are used in this way at the beginning of a sentence, they are normally separated from the rest of the sentence by a comma. For information about the meaning of various sentence modifying adverbs, see Section 3.5 *Signposting*.

■ using phrasal verbs

Phrasal verbs consist of a verb plus a preposition, or a short adverb acting like a preposition, that combine to create a meaning different from the usual meanings of the individual words. Most of the words that make up phrasal verbs are short and frequently used. They function like normal verbs, but because they are idiomatic, they can create special vocabulary problems for non-native writers. Phrasal verbs are more suitable or appropriate for use in informal English, though some are quite acceptable in scientific report writing.

Formal	<i>reduce in amount</i>	<i>remove</i>	<i>calculate</i>	<i>postpone</i>	<i>abolish</i>	<i>conduct</i>
Informal	<i>cut down</i>	<i>cross out</i>	<i>work out</i>	<i>put off</i>	<i>do away with</i>	<i>carry out</i>

Now, *carry out* the imaginary operation of inserting a thin layer of one material, arbitrarily labelled as no. 1, between the two dissimilar materials at every interface in the body.

5.2 Articles

Correctly using and choosing the proper article is one of the biggest problems in English grammar.

- The **indefinite articles**, *a / an*, can be used to talk about
 - * objects or ideas in general
 - * one particular person or thing, when it is mentioned for the first time, or when the reader does not know which one is meant, or when it does not matter which one.
- The **definite article**, *the*, can be used
 - * when the noun is singled out as unique or specific
 - * when the reader already knows which particular person(s) or thing(s) etc you are talking about.

What are the basic rules for using the articles?

The **indefinite article** (*a / an*) is used with singular countable nouns referring to a non-unique item in general:

- separate objects, people, ideas, etc.

singular	a microscope	a scientist	a plan
plural	five microscopes	a large number of scientists	several alternative plans

The **definite article** (*the*) is used with nouns referring to a unique specific item. A noun can have a definite article when

- it is modified by a superlative or ordinal number

the first experiment *the* last measurement *the* most significant results *the* only time

- it refers to an entire type or species

The telephone can be used to transfer data

- it refers to an item previously mentioned

They connected a phone line to a modem. *The* modem was connected to a computer in order for *the* computer to access the internet.

- there is only one of something or it is fully specified by the context or background knowledge

The periodic table is often used in chemistry.
The internet is now used by millions of people across *the* world.

- it is followed by *of* + noun phrase

The coefficient of expansion of brass is 0.000026°C.
The importance of international co-operation is emphasised in the report.

Note: Some generalisations may be needed in scientific use, in which case *the* is left out in long, complex, uncountable or plural noun phrases, in particular those including an *of* + noun phrase. In these sentences, both options, i.e. using the articles or omitting them, are correct.

(The) Little-known sources of air pollution are misfires in a car's engine.
(The) Creation of the simulation model allows for a degree of optimisation of (the) engine performance.

What is the difference between *countable* and *uncountable* nouns?

The distinction between these two types of nouns is very important in English and understanding this will help you to use articles more accurately. Most nouns are either countable or uncountable, while some can be either, depending on the meaning or the context.

Countable nouns are things we can count. We use them with the indefinite article *a / an*, and we can make them plural.

car table job experiment employer teacher laboratory suggestion

Uncountable nouns are things we cannot count. They include many abstract nouns that you may use frequently in scientific writing. They have no plural form and cannot be used with the indefinite article *a / an*. When you want to itemise these nouns, you have to add a phrase like *a piece of ...*

information advice music money progress research work travel luggage

The use of articles with countable and uncountable nouns is as follows:

	indefinite	definite
countable - singular	I've got <i>a new job</i>	<i>The job</i> is interesting
countable - plural	They've got <i>new jobs</i>	<i>The jobs</i> are interesting
uncountable	I've got <i>work</i> now	<i>The work</i> is interesting

Some words which are basically uncountable nouns can also be used as countable nouns with a somewhat different meaning, and this applies to many words in scientific and technical English.

- As uncountable nouns, they refer to something general, e.g.

metal, fuel, material, mass, velocity, pressure, power, water, analysis, science, sound, temperature

- As countable nouns, they refer to something more specific, one or more of a set, e.g.

a soft metal a carbonated water a velocity of 25 m. per second an analysis of this problem

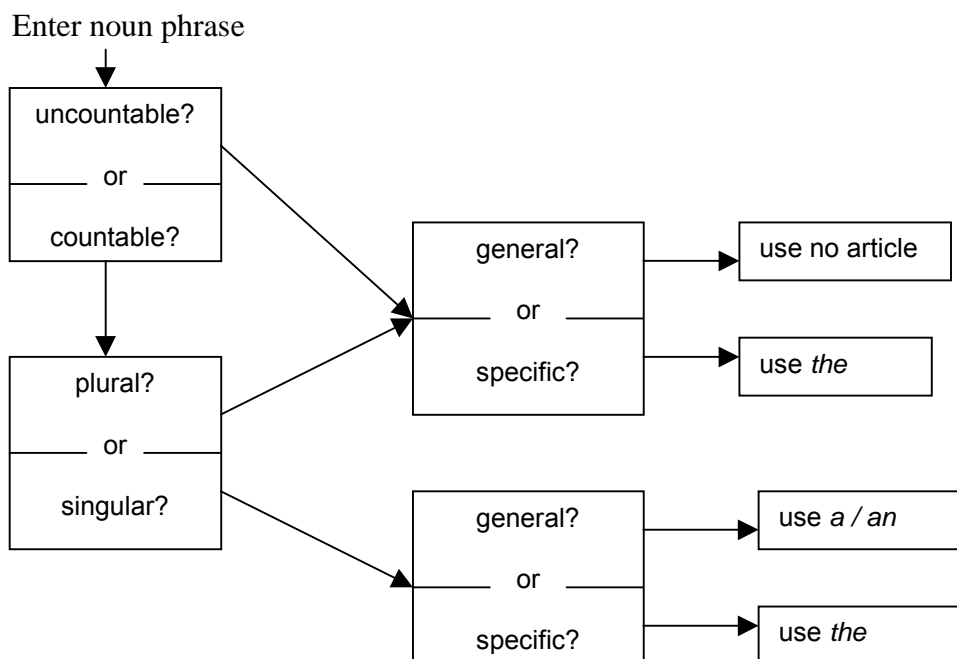
Example sentences. Note that the countable version of the noun is used when it is defined in some way, either by an adjective or an *of* phrase.

uncountable	countable
A thermometer measures <i>temperature</i> . <i>Temperature</i> is generally expressed in degrees.	The thermometer showed <i>a temperature</i> of over 50°C. The boy had <i>a high temperature</i> .
This factory produces <i>steel</i> .	Cheaper mild <i>steels</i> are now being produced.
Water is composed of <i>hydrogen</i> and oxygen.	A water molecule is composed of <i>two hydrogens</i> and on oxygen.
This problem is beyond human <i>understanding</i> .	<i>A clear understanding</i> of the practical implications lies at the heart of successful flow modelling.

How can I choose the correct article?

Here is a flow chart which may aid you in correctly choosing the proper article. The following example will help you to use the flow chart (the analysed nouns are in italics):

One form of listening to (*music*) (1) is by using CDs. The CD is (*digital system*) (2). The player's laser reads a series of (*on/off pulses*) (3), without physically touching the disc's surface. Not every pulse must be read accurately – as long as the number of reading errors remains below a certain limit, (*reconstruction*) of (*music*) (4) is complete. But if the number of errors rises above that level, the player loses the sound for a moment. (*CD players*) (5) contain (*electronics*) (6) which perform 'error correction', filling or bridging gaps when pulses are missing or mis-read.



- 1 *music* : this is uncountable, general (there are many kinds of music). Therefore use *no article*
- 2 *digital system*: the noun is countable, singular and general (there are many different systems). Therefore use *a*: *a digital system*
- 3 *on / off pulses*: the noun is countable, plural, general. So use *no article*.
- 4 (*reconstruction*) of (*music*): *reconstruction* is countable, singular and specific (defined by the *of* phrase): so use *the*. *Music* is uncountable, but here specific, referring back to the music mentioned earlier: so use *the*.
- 5 *CD players*: the noun is countable, plural and general (since there can be many players): so use *no article*
- 6 *electronics*: this noun is uncountable and general, referring to the whole range of electronic systems that might be applicable. So use *no article*.

The complete text would be:

One form of listening to *music* is by using CDs. The CD is *a digital system*. The player's laser reads a series of *on/off pulses*, without physically touching the disc's surface. Not every pulse must be read accurately – as long as the number of reading errors remains below a certain limit, *the reconstruction* of *the music* is complete. But if the number of errors rises above that level, the player loses the sound for a moment. *CD players* contain *electronics* which perform 'error correction', filling or bridging gaps when pulses are missing or mis-read.

5.3 Numbers

How do I express numbers in my writing?

When is it necessary to write numbers as numerals (1, 2, 3, 4 ...) or as words (one, two, three, four, ...)? The answer is always to present your work as clearly as possible. Is your text unreadable because of an overloading of numerals or, in contrast, are some important figures unnecessarily hidden within the text?

The following are some general rules which should be followed, including correct examples:

- Numerals should not be used at the beginning of a sentence.

--

- Numerals should not be used in succession or in a series of numerical facts.

--

- Numerals should not be used for round number estimates or ordinals.

--

- Use numerals for all page numbers, dates, figures, diagrams, addresses.
- For numbers below ten, words tend to be preferred to numerals.

5.4 Passive Voice

The passive voice is frequently used in technical and scientific writing because the form is impersonal and objective. The action is felt to be more important than the agent or the performer of the action.

action	agent
The survey was conducted	by the Pristop Communication group.

What types of passive construction are there?

with an agent stated	To avoid tensile stress reflecting from the free boundaries, a star-shaped flyer plate <i>has been proposed by Kumar and Clifton.</i>
without an agent stated	The distance between the bars <i>was measured.</i>

Which are the most common passive tenses used in technical and scientific writing?

- **Present passive.** We normally use the present passive tense when describing a process or procedure or when making general statements of fact.

Paper *is made* from wood.
The trees *are cut* down.

- **Past passive.** When we report a particular procedure and are concerned with only one particular occasion in the past; then we use the past passive tense.

The capillary *was filled* with mercury and all air *excluded*. Air *was admitted* to the chamber and *heated*.

- **Present perfect passive.** This tense is often used in the introduction where you might want to refer to things relating to your work that have happened, or been said, recently.

For example, it *has been suggested* that cathepsin S promotes motility of cilia. On the other hand, the possibilities of computational modelling *have increased* in the last few years, enabling the models to be much more realistic.

- **Passive with modals.** These are commonly found in technical and scientific writing in such phrases as

It cannot be assumed that ... It should be made clear that ...

Points to check in your writing

- the passive forms *is placed on / given to / by* are preferable in English to the active

During the last two years of study, increasing emphasis *is placed* on practical training.
Figure 6 in the previous section shows that, for the Lorenz system, better results *are given* by quadratic than linear functions.

- using passive constructions is one way of avoiding the first person singular in technical or scientific writing

It can be concluded that ...

- In long sentences active constructions are better because the verb in passive constructions could come at the end of the sentence, which makes a construction clumsy.

passive	For this reason, the emission and excitation spectra of Hg ₂ CL ₂ luminescence on virgin samples and samples exposed to UV light and X-ray <i>were studied</i> .
active	For this reason, <i>the subject of the study was</i> the emission and excitation spectra of...

- Overuse of the passive should be avoided. Variation between active and passive verb forms keeps the reader more interested.

In domestic trade, more than 50% actual sales *are derived from* wood and building materials, while the rest *comes from* furnishing materials for buildings and engineering services.

5.5 Punctuation

Proper punctuation makes a text clear to understand. Wrongly placed punctuation marks may make a sentence ambiguous or even change the meaning. Each punctuation mark serves a purpose and conveys a signal to the reader.

Apart from capital letters and full stops, the most common punctuation marks in technical and scientific writing are:

comma	,
colon	:
semi-colon	;
brackets / parenthesis	() []
dash	--
hyphen	-
apostrophe	'

How are the punctuation marks used?

- Comma. This is used

- * between two independent clauses with different subjects if they are part of a series or are joined by *and*, *but*, *so* and *or*.

The reactor was out of control, the content overheated, <i>and</i> the safety valve failed.
The diagnostic work is normally done by the computer, <i>but</i> the technician must be able to understand the various computer operating systems and to use the system's software.

- * if the subordinate clause comes before the main clause in a sentence

comma	<i>When</i> the liquid boils, a residue is formed.
no comma	A residue is formed when the liquid boils.

- * to separate a non-defining relative clause from the rest of the sentence. Note that you have to use *which* or *who*, but not *that* in these sentences. *That* can be used in defining relative clauses, and there is no comma.

Brass, <i>which</i> is an alloy of copper and zinc, is used to make bolts and screws.
The experiments <i>that</i> were described in the previous section were part of a series <i>that</i> was conducted over a range of mode mixes.

- * in a series of three before a conjunction

The bridge circuit consists of four tensometers, a signal source, and a detector.

Some writers leave out the comma before the last item in the series, but then there is the danger of ambiguity. If in doubt, put a comma in.

without final comma	The liquids we analysed were neat methanol, neat ethanol, methanol and 10 percent water and ethanol and 10 percent water.
with final comma	The liquids we analysed were neat methanol, neat ethanol, methanol with 10 percent water, and ethanol with 10 percent water.

- * to separate linking words and phrases from the rest of the sentence.

<i>On the other hand</i> , the chances of success are great.
--

The chemical engineer's greatest contribution, <i>however</i> , will be in the development of new energy systems.

- * to separate some adverbs, adverbial expressions or other introductory phrases from the rest of the sentence

<i>Additionally, from the technical point of view</i> , the human arm is admirable due to its sensitivity and versatility.
--

<i>Using physical principles</i> , the thin layers, CN, TIN, AIN ..., can be grown and modified

<i>To avoid undesirable failure during the test</i> , cover the test stand.

It is often essential to separate the initial phrase to avoid confusion or ambiguity:

unclear meaning	After water proteins are the main component of the body.
------------------------	--

clear meaning	After water, proteins are the main component of the body.
----------------------	---

- * to provide extra, supporting or explanatory information about a term, in parenthesis

A completed marriage of CAD and CAM results in a CAD/CAM system, <i>or CADAM system</i> .

ASHRAE, <i>the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.</i> , lists the following job titles that technicians and technologists may qualify for.
--

- * note that there is no comma before *that* in reported speech:

wrong	He proved, that the substance would not disintegrate at high temperatures.
--------------	--

correct	He proved that the substance would not disintegrate at high temperatures.
----------------	---

▪ Colon

- * The colon is most frequently used before a list of items, often preceded by a word like *namely, such as, as follows, the following, etc.*

Please send the items indicated below, <i>namely</i> : (i) passport (ii) visa application (iii) correct fee.

- * You can also use the colon when introducing a task or tasks to perform.

Study the following graph, which shows recommended speeds for carbon steel drills on soft steel:

▪ **Semi-colon**

- * the semi-colon is weaker than a full stop, but stronger than a comma. You can use it to join two independent but closely related sentences

This section will consider the communication electronics technician; another section will be devoted to the computer electronics technician.

- * you can also use the semi-colon in complicated lists, for example, to show sub-grouping

Six excellent career fields within mechanical engineering technology are heating, ventilating, and air conditioning (HVAC); mechanical design and tool design; numerical control (NC); technical sales; fluid power; and laser technology.

▪ **Brackets or parentheses**

- * **round brackets** are used for cross-references, abbreviations, definitions, and other subsidiary information

Engineers are developing ideas for tapping hydrate energy sources (*see box on page 56*).

Large-Eddy Simulation (*LES*) has developed into a promising and potentially powerful technique for flow modelling and numerical control.

These computers must be serviced periodically by computer service technicians (*often called 'field engineers or customer service engineers'*).

- * you can use **square brackets** when you want to insert a word of your own into a quotation so that it makes good, grammatical sense and completes the meaning of the sentence

The report stated that 'world reserves [of natural gas] will probably last for 70 years'.

▪ **Dash**

- * You can use a dash in the same way as round brackets to add extra, less important information. The dash, however, is somewhat informal, so it is not so often used in scientific reports as commas or brackets

A study on the modelling of waste flow in the city of Chemnitz demonstrated the applicability of the applied software – UMBERTO.

Mechanical design technicians are the communicators of industry. They prepare – or supervise the preparation of – assembly drawings.

▪ **Hyphen**

- * hyphens are used to join words to make new words. The rules for hyphens are complicated and vary in different publishing houses and between

individual writers. American English uses rather fewer hyphens than British English. If you are in doubt, check in a dictionary.

- * hyphens are most commonly used in the following kinds of compounds:

noun – adverb	<i>hands-on applications</i>
adjective compounds in <i>-ed</i> or <i>-ing</i>	<i>cone-shaped piece of stock</i> <i>problem-solving steps</i>
coordination compounds	<i>Paper-and-pencil skills</i> <i>Garbage in-garbage out (GIGO) is the description the computer personnel used for invalid data inputs and sometimes disastrous results</i>
Compounds expressing numerals and fractions	<i>two-dimensional shapes</i> <i>four-sided figure</i> <i>8-foot length</i>
Compounds in which the first base is a single capital letter	<i>U-turn</i>
after certain prefixes, e.g. <i>ex-</i> , <i>half-</i> , <i>non-</i> , <i>quasi-</i> , <i>self-</i> , etc	<i>half-time, quasi-state, non-existent, self-study</i>

- * phrases which have no hyphen normally have to have them when used as an adjective phrase before a noun

open phrase	phrase used as an adjective
The investigation was carried out on the spot.	They carried out an <i>on-the-spot</i> investigation.
He is out of work.	He is an <i>out-of-work</i> miner.

Apostrophe

- * you use an apostrophe most frequently to indicate the possessive, either singular or plural. The same meaning can be expressed by a phrase with *of*.

apostrophe	of phrase
Checking a <i>product's</i> quality characteristics is called inspection.	Checking the quality characteristics <i>of a product</i> is called inspection.
Technical sales involves the selling of machine technology to meet <i>customers'</i> specific needs.	Technical sales involves the selling of machine technology to meet the specific needs <i>of customers</i> .

- * you use it when referring to other scientists' work. When referring to two or more people together, the apostrophe goes after the last name. When you refer to a famous or generally accepted discovery, the apostrophe is not needed.

other scientists	<i>Zarka's</i> method To coincide with Ponte <i>Castaneda's</i> lower bound for the strain potential ... In this paper, <i>Cauchy's</i> and <i>Novozhilov's</i> measures of mean rotation are compared
2 scientists	<i>Iwan and Moeller's</i> (1976) work appears to be the first publication

together	on this subject.
famous discovery	the <i>Curie</i> point, the <i>Doppler</i> effect

- * The apostrophe can also be used to form plurals of numbers, abbreviations, and symbols, though it can also be left out:

the early 1990's (OR: the early 1990s)
first add up all the X's (OR: first add up all the Xs)

Some other punctuation conventions in technical/scientific writing

- **three dots** are used to indicate an unfinished sentence or sequence

In a similar manner, multiplication factors of 1, 2, 3, ... can be achieved.
--

- the **oblique stroke** or **slash** is used to abbreviate your text, especially when you want to specify alternatives or sub-sectioning

highly efficient input / output features
I / O features
students and / or staff

- quotation marks, italics, bold face and capitals can be used to indicate emphasis

Now that we have the “ <i>big picture</i> ” of industrial automation, we can appreciate two of the main components of the factory automation scheme.
--

5.6 Verb Tenses

In scientific and technical writing the choice of verb tenses is quite limited. The most commonly used tenses are

- the simple present
- the simple past
- the present perfect.

How is the present tense used?

It is used to state facts that are generally valid from the point of view of the writer. Therefore, use it in the following situations:

- * when writing about your topic or background

Lasers <i>are</i> devices which <i>amplify</i> light and <i>produce</i> beams of light which <i>are</i> very intense, directional, and pure in colour.
--

Little <i>is known</i> about HPS systems , which <i>are</i> the subject of the following chapter.

- * when explaining your purpose

Here we *investigate* the properties of the above mentioned metals.

The perturbation method we *develop* here *applies* to any crack geometry as long as the crack-face weight function solutions are known for the corresponding reference crack.

- * when presenting results, if the findings are general facts

In cases when the eigenvalue of interest *is well separated* from the others, K_2 *tends* to increase the natural frequencies of the forward and backward waves but decrease the natural frequency of the reflected wave, just opposite to the effect of M_2 .

- * when making general statements, e.g. in conclusions

This observation *indicates* an obvious inconsistency that *is avoided* by the introduction of generalised principles.

The author *believes* that one particular application, where the results can be useful, *is* the modelling of contact problems involving anisotropic materials.

There are differences in the way the **passive** and the **active** forms are used:

- * the present simple passive is used when describing a process or procedure (see Section 4.4 on the Passive Voice)
- * the present simple active is preferred in physical descriptions, such as describing a piece of apparatus or equipment

The plotter *represents* another important output device. The plotter *makes* hard copy of the product represented by digital information in the computer. Most CAD systems *use* a pen plotter.

How is the past tense used?

You use this when referring to specific tasks carried out, such as taking measurements, conducting experiments, describing methods actually used, or presenting your results and conclusions from the particular piece of work.

- * The past simple passive is mainly used when we report a particular procedure related to only one particular occasion in the past. (See Section 5.4 on *Passive Voice*)

In Fig.4 the uniaxial curve *was calculated* using Eq. /51/, the deviatoric stress-strain curve *was calculated* using Eq./20/, and the hydrostatic stress-strain curve *was calculated* using Eq./52/.

Experimental results *were obtained* by the use of surface wave transducers, which *were placed* on two perpendicularly intersecting faces of a polished aluminium block.

- * The past tense is also used in the introduction to give historical background or development in the field of interest:

Technologists and craftspeople of early civilisations *built* huge objects. Algebra and trigonometry *were well understood* and *applied* during those early years. Construction of the pyramids of Egypt and of Central and South America *required* experience and the labour of many people.

I *started* my research at the beginning of this term.

- * The past tense is commonly used in acknowledgements:

The work, which *led* to this paper, *was sponsored* by the Natural Sciences and Engineering Research Council of Canada. This financial support is greatly appreciated.

How is the present perfect used?

- * It is commonly used in the introduction, particularly when you want to recapitulate the state of the art and show what work has been done and is still in progress. (See also Section 4.4 on the Passive Voice)

Recent progress in materials science, the development of new sophisticated application-designed materials, and especially the unique qualities of composite materials, *have given* a renewed interest in the problems arising when several different material phases interact with each other.

This chapter *has provided* you with career information that will help you decide whether or not to pursue a technical degree.

What other tenses are used in scientific and technical writing?

▪ Present Continuous

- * This can be found in reports on studies or research, mainly in the introduction. You use it when you want to stress that something is currently in progress or is only temporary.

I *am studying* for a Ph.D. at Brno University of Technology.

I *am doing* research into the problems of industrial waste.

▪ Past Perfect

- * This is not commonly used in technical/scientific writing. However, it is the tense you would use if you want to indicate that one action preceded another action in the past.

The epoxy, a modified bisphenol that *had been mixed* with an amido-amine hardener, was cast directly to the glass and cured at room temperature for at least a week.

▪ Future tense with *will*

- * This is not so frequently used as the present and past tenses. Use it when explaining how you intend to present information, give examples or describe visuals. It also indicates future events or parts of your work that come later.

The following examples of converting English units *will employ* a technique known as multiplying by the unit ratio.

We *will consider* here the operating environment.

Item number 1 'concrete' *will be examined* to clarify further the spreadsheet results.

- * **NOTE:** Do not use the future tense in the subordinate clause in time or conditional sentences (with *When ...* or *If ...*, etc.)

The real value of the spreadsheet *will be seen* when the next survey *is conducted*.

After the collected information *is entered* into the computer, the new minimum and maximum costs *will be automatically calculated*.

▪ Conditional

- * In technical and scientific writing, the conditional is mainly used in acknowledgements:

The authors *would like* to acknowledge the support of the National Science Foundation through Grant number CDR 589712.

Both professionally and personally, I *should like* to thank just some of the many people who have influenced this book.

Points to check in your writing

- Within one paragraph, it is not usual to shift tenses unless there is a good reason to do so. The example below is the final paragraph of the introduction to a scientific paper. This paragraph
 - * summarises the purpose of the paper (in the past tense),
 - * states the current state of development in the area of interest (present perfect),
 - * indicates the aim of the paper (future tense), and
 - * reports the results performed by the authors (past tense).

The purpose of the work presented here *was* to examine interfacial crack initiation over a wide range of mode mixes. The analysis and development of a suitable specimen and biaxial device *have* already *been described*. This paper *will present* the results and analysis of a series of experiments that *were conducted* with various combinations of tensile and positive or negative shear loads.

- When all verbs describe a sequence of actions or states, their tenses should be the same. This is often the case in describing an experiment.

In the petroleum industry, one of the most widely used methods for enhancing production *is* the hydraulic fracturing process. The method *involves* packing off a section of a borehole in the “pay zone” and hydraulically pressurizing it until the formation *fractures*. The fracture *is* then *propagated* by keeping the borehole pressurized, typically by controlling the flow rate at the surface.

- variation between passive and active constructions is strongly recommended to keep the reader interested. (See Section 4.4 on the Passive Voice.)
- check your use of tenses in *if* clauses (see above)

If the relative width of the tube *is* greater than 20, then the difference *is* /*will be* hardly affected by h. If the experiments *were carried out* by introducing edge conditions nearer to true simple supports than those imposed within tubes, the buckling loads *could be* higher than those obtained in tube experiments.

5.7 Word Order

English is generally considered to be a language with a relatively fixed word order. In practice, this means that the positions of the subject **S**, the main verb **V**, and the object **O** are fixed in relation to each other. In normal statements, which form the bulk of technical and scientific writing, these items occur regularly in the order **S-V-O**.

subject (S)	verb (V)	object (O)
Many flexible objects and structures	undergo	large deformations.

The problem in technical and scientific writing is that parts of a sentence, particularly the subject, can become too long and complex, and therefore the basic structure may not be always clear.

The subject

- With longer subjects, it is very important to keep together the words that form the subject.

The formulas for the uniaxial and hydrostatic stress-strain relationship given by Eqs. 49 and 50 are based on a model consisting of an infinite number of elastoplastic elements connected in parallel.

- However, you should avoid overlong subjects. It is difficult for the reader to process a long structure without losing the sense of the sentence as a whole. In such cases, it is much better to re-formulate the sentence. One way of doing this is to turn the verb into a noun, which then forms the subject of the sentence. This new subject is short and the new verb, which is often in the passive, is introduced as early as possible and is not left dangling at the end of the sentence.

overlong subject	In this article, <i>the results of the studies into the role of different parts of the society in applying several types of economic incentives for waste management</i> are summarised.
improved sentence	In this article, <i>a summary</i> is given of the results of studies into the role of different parts of society in applying various types of economic incentives for waste management.

The verb

- The verb should be positioned as close to the subject as possible. The mistake of placing the verb at the end of the sentence after an over-long subject has been mentioned above.

No damage *was observed* in the specimen due to the uniaxial compressive stress.

- The regular pattern **S-V** is inverted when you want to signal the existence or presence of something new by using *there is / are / was / were*, etc.

There has been relatively little examination of the effect of mode on subcritical crack growth.

- Similarly, the subject - verb word order is changed when you start a sentence with *It is / was ... that ...* to show emphasis. See Section 3.5 Emphasising.

The objects in a sentence

- The direct object comes as close as possible to the verb, and normally before prepositional or adverbial phrases.

We have sent *a new type of laser* to the research, development, and testing office in Seattle.

The position of adverbial phrases

The most flexible elements in a sentence are the various kinds of adverbs and adverbial phrases. They are the most movable as they can occur at the start, in the middle or at the end.

With the star-shaped flyer plate, cracks are observed to have formed *at the middle of each free edge of the sample*.

Various numerical methods were *recently* developed for engineering problems.

- The first element in the sentence attracts most attention. It is usually the subject but if another sentence element is to be emphasised, it comes first. (See Section 3.5 Emphasising). A comma is often used to separate this structure from the rest of the sentence (See Section 4.5 Punctuation).

In industry, large databases are maintained on manufacturing processes.

When purchasing a monitor, the number, or density, of pixels is a good guideline.

- The position of the time reference at the beginning of the sentence does not necessarily mean that this structure is emphasized. The time reference can be used as a convenient introduction in order to avoid breaking the flow with too many interruptions.

This year again, our research group will introduce new methods developed within the project CZ 521896.

- When the place reference comes first, the use of the passive can be used.

In a Dirichlet-type of problem, T is specified; T M and F M are computed from relative sizes and positions of the holes.

- It is best to avoid using more than one adverbial phrase at the beginning of a sentence.

With respect to the base parametrization, three model types are included in this study.

How to position *also*

- Generally, *also* is placed after the auxiliary verb (if there is one), but before the stem verb

Finite element schemes also exist for determining the weight functions numerically.

Systematic errors may be caused by the environment, the instrument, or the experimenter.

Systematic errors may also be identified and eliminated during the laboratory.

- If *also* functions as a link word for the sentence as a whole, then it is best to place it AFTER the subject of the sentence rather than as the first word.

These procedures provide the ability to visualize externally applied forces. They also require the differentiation of constraint functions, which are not given any geometrical significance.

Points to check in your own writing

- *Have I avoided long noun phrases, with verbs left dangling at the end of a long sentence? Can I rewrite the sentence to make it more readable?*
- *Have I used a variety of adverbial phrases at the start of sentences, to give the right emphasis to my ideas?*
- *Most importantly, have I used the best word order to convey my points clearly to the reader?*

Chapter 6

WORDS

6.1 Abbreviations

In scientific writing, there are a number of abbreviations in use which originate from Latin or Greek. In general it is not a good idea to use too many of these within the body of your writing, but they can be used occasionally when needed, and they are often necessary in your references and bibliography.

Below is a selection of common abbreviations and their English equivalents.

abbreviation	Latin words in full	meaning
AD	anno Domini	since the birth of Christ
a.m.	ante meridiem	in the morning
BC		before Christ
c. or ca.	circa	approximately, about (for dates)
cf.	confer	compare
e.g.	exempli gratia	for example, for instance
et al.	et alii / et alia	and others
etc.	et cetera	and so on, and the rest
et seq.	et sequens	and the following pages
ibid.	ibidem	in the same place / book
i.e.	id est	that is, in other words
	inter alia	among other things
loc.cit.	loco citato	in the place mentioned
NB	nota bene	note well (for an important point)
op. cit.	opere citato	in the work mentioned before
p.a.	per annum	a year, each year
	per capita	per head
p.m.	post meridiem	in the afternoon, evening
	passim	at various points in the book, recurrent
q.v.	quod vide	see in another place in the same book (for a cross-reference)
v. / vs.	versus	against
viz.	videlicet	namely (naming something you have just referred to)

6.2 Prefixes

A common way of making new words in English is by adding standard combinations of letters to existing words, either at the beginning (prefixes) or at the end (suffixes). By noting these carefully, you will find it easy to increase your vocabulary.

A prefix is a syllable, 2 syllables, or sometimes even a word, put at the beginning of a word to change its meaning or to make another word. Prefixes are often used to give an adjective, a verb or a noun a negative meaning, but there are also lots of other prefixes with specific meanings.

Prefixes with the meaning *not*

The most common prefixes used to give a negative meaning to adjectives, and some verbs and nouns, are as follows:

prefix	use	positive	negative
<i>un-</i>	used with many different words	lucky friendly employed	<i>un</i> lucky <i>un</i> friendly <i>un</i> employed
<i>im-</i>	used before words beginning with <i>m</i> or <i>p</i>	possible mature	<i>im</i> possible <i>im</i> mature
<i>il-</i>	used before some words beginning with <i>l</i>	literate legible	<i>il</i> literate <i>il</i> legible
<i>ir-</i>	used before some words beginning with <i>r</i>	regular responsible	<i>ir</i> regular <i>ir</i> responsible
<i>in-</i>	used before a limited number of words	correct visible	<i>in</i> correct <i>in</i> visible
<i>dis-</i>	used before some adjectives and a few verbs	honest like	<i>dis</i> honest <i>dis</i> like

Unfortunately, there is no easy way of knowing which prefix any adjective will use to form its negative. So when you learn a new adjective, note down whether it has an opposite formed with a prefix and, if so, what it is.

- **The prefix *in-*.** This does not always have a negative meaning – often it gives the idea of inside or into, e.g. *internal*, *insert*, *income*.
- **Verb prefixes: *un-* and *dis-*.** These prefixes have two meanings. They can have a negative meaning (as above), but they can also mean 'the opposite of an action' or 'to reverse an action'. This meaning is used with certain verbs, e.g. *to lock* – *to unlock*, *to pack* – *to unpack*, *to appear* – *to disappear*, *to get dressed* – *to get undressed*.

Other prefixes with specific meanings

Many other prefixes are used in English. Below is a list of prefixes which are useful in helping you to understand unfamiliar words. Some of these words are used with a hyphen. Check in a dictionary if you are not sure.

Prefix	Meaning or Function	Examples
<i>a-</i> (<i>an</i>)	not, not having	<i>atypical</i> , <i>anhydrous</i> (not containing water)
<i>aero-</i>	air	<i>aerospace</i>
<i>anti-</i>	against	<i>anti-toxin</i>
<i>auto-</i>	self, by itself	<i>autointoxication</i>
<i>bi-</i>	two	<i>bi-metallic</i>
<i>bio-</i>	life	<i>biology</i> (science of life)
<i>centi-</i>	100 or 1/100	<i>centimeter</i> , <i>Centigrade</i>
<i>co-</i>	together, with	<i>co-operation</i>
<i>contra-</i> <i>counter-</i>	against, opposite	<i>contra-rotating</i> , <i>counteract</i>
<i>de-</i>	taken away from	<i>dehydrated</i>
<i>deci-</i>	a tenth	<i>decimeter</i> (tenth of a meter)
<i>deka-</i>	ten	<i>dekameter</i> (ten meters)
<i>di-</i>	two, twice	<i>dioxide</i>
<i>hydro-</i>	(1) water	<i>hydrology</i>

	(2) hydrogen	<i>hydrocarbon</i>
<i>hyper-</i>	over, excessive	<i>hypertension</i>
<i>hypo-</i>	below, less than usual	<i>hypotension</i>
<i>infra-</i>	below, under	<i>infra-red</i> (below the wavelength of red)
<i>inter-</i>	between	<i>interconnection</i>
<i>intra-</i>	inside	<i>intravenous</i>
<i>iso-</i>	equal	<i>isostatic</i>
<i>kilo-</i>	a thousand	<i>kilogram (me)</i> (1000 gram (me)s)
<i>macro-</i>	large, on a large scale	<i>macromolecule</i>
<i>mega (lo)-</i>	very large, a million	<i>megawatt</i> (a million watts)
<i>meta-</i>	change	<i>metamorphic</i>
<i>micro-</i>	small, on a small scale	<i>microorganism</i>
<i>milli-</i>	a thousandth	<i>milligram (me)</i> (1000th of a gm)
<i>mis-</i>	badly, mistakenly	<i>miscalculated</i>
<i>mono-</i>	one, single	<i>monochrome</i> (of only one colour)
<i>multi-</i>	many	<i>multilateral</i> (with many sides)
<i>neo-</i>	new	<i>neoclassical</i>
<i>non-</i>	not	<i>non-conductor</i>
<i>out-</i>	(1) more than (2) beyond, outside	<i>outwear</i> (wear or last longer than) <i>outlying</i> (beyond the main body)
<i>over-</i>	(1) more than, excessive (2) on top of, above	<i>overproduction</i> <i>overlie</i> (to lie on top of)
<i>para-</i>	similar to, irregular	<i>paratyphoid</i> (disease similar to typhus but of different origin)
<i>pent (a)-</i>	five	<i>pentagon</i> (5 –sided figure)
<i>phot (o)-</i>	light	<i>photosynthesis</i>
<i>poly-</i>	many	<i>polymorphous</i>
<i>pre-</i>	before, previously	<i>prearranged</i>
<i>proto-</i>	first, original	<i>prototype</i>
<i>quadri-</i>	four	<i>quadrivalent</i> (having a valency of 4)
<i>re-</i>	(1) again, back (2) together, mutually	<i>re-combine</i> (to combine again after being separated) <i>react</i> (to act on each other)
<i>self-</i>	by itself	<i>self-regulating</i>
<i>semi-</i>	half, imperfect	<i>semi-conductor</i>
<i>sub-</i>	under, below, less than	<i>sub-atomic</i>
<i>super- (supra)-</i>	above, beyond, more than	<i>supersonic</i>
<i>syn- (m)-</i>	with, together	<i>synthesis</i>
<i>tetra-</i>	four	<i>tetrad</i> (element having valency of 4)
<i>therm-</i>	heat	<i>thermodynamics</i>
<i>tri-</i>	three	<i>triangle</i>
<i>ultra-</i>	beyond, more than usual	<i>ultraviolet</i>
<i>under-</i>	(1) less than, insufficient (2) below, lower than	<i>underpressure</i> <i>undersea</i>
<i>uni-</i>	one	<i>unicellular</i>

6.3 Suffixes

A suffix is a syllable or syllables put at the end of a word to change its word-class and / or its meaning. Suffixes can briefly be divided into

noun suffixes	<i>complication</i>
adjective suffixes	<i>flexible</i>
verb suffixes	<i>minimise</i>

Noun suffixes

- Verb + suffix. Many nouns are formed by adding a suffix to a verb. The most common suffixes of this type are as follows:

Verb	Suffix	Noun
enlarge	-ment	enlargement
elect	-(t)ion	election
inform	-ation	information
write	-ing	writing
dance, manage	-er	dancer, manager
direct	-or	director

* **Note:** sometimes there is a spelling change. The most common is the omission of the final e before the suffix -ion or -ation: *translate / translation*.

- Noun + suffix. -ist is a common suffix added to existing nouns to describe people and their jobs : *ecologist, journalist, artist*.
- Adjective + suffix. Nouns are also formed by adding a suffix to an adjective. Two suffixes often added to adjectives to form nouns are -ness and -ity.

adjective	suffix	noun
rich	-ness	richness
stupid	-ity	stupidity

Adjective suffixes

- Noun or verb + suffix. Adjectives can be formed from nouns or verbs by adding these suffixes:

noun or verb	suffix	adjective
fame	-ous	famous
industry	-al	industrial
sun	-y	sunny
create	-ive	creative

- Suffixes can change word class, e.g . from verb to noun, or noun to adjective, but they can also change meaning. The suffixes -able and -ible quite often have the meaning of *can be done*, e.g. something that is *comprehensible* can be comprehended.
- Words ending in -ible often add the prefix *in-* for their negative forms: *incomprehensible*
- The suffix -ful often means 'full of': *colourful* = full of colours.
- The suffix -less means 'without': *odourless* = without odour

Here is a list of common suffixes in alphabetical order, their meaning or function and some examples

Suffix	Meaning or Function	Example
-able	(1) forms adjective from verb (2) with verb means "can be done"	<i>reliable</i> <i>drinkable, countable</i>
-age	(1) forms noun from verb (2) forms abstract noun with idea of aggregation	<i>storage</i> <i>tonnage</i> (total number of tons)
-al	(1) forms adjective from noun (2) forms noun of action from verb	<i>physical, legal</i> <i>trial</i> (action of trying or testing), <i>arrival</i>
-an (see -ian)		
-ant (-ent)	forms noun and adjective from verb	<i>resistant, determinant</i>
-ate	(1) in the shape of, like	<i>dentate</i> (in the shape of a tooth)

	(2) possessing	<i>nucleate</i> (having a nucleus)
- <i>ation</i>	forms noun from verb	<i>information, organisation</i>
- <i>cy</i>	forms noun from adjective	<i>accuracy</i>
- <i>ent</i> (see - <i>ant</i>)		
- <i>er</i>	forms noun from verb (1) person who does an activity (2) used for things which do a particular job	<i>computer</i> <i>writer</i> <i>bottle-opener</i>
- <i>ful</i>	forms adjective from verb	<i>forgetful, hopeful</i>
- <i>hood</i>	forms abstract nouns especially family terms	<i>childhood, motherhood</i>
- <i>ian</i>	(1) forms personal noun from sciences (2) forms personal noun from countries	<i>mathematician</i> <i>Australian</i>
- <i>ible</i>	see – <i>able</i>	
- <i>ify</i>	forms verb from noun or adjective	<i>intensify</i>
- <i>ine</i>	forms adjective from noun	<i>saline</i> (having the property of salt)
- <i>ing</i>	forms noun from verb	<i>jogging, spelling</i>
- <i>ion</i> (see – <i>tion</i>)		
- <i>ise</i> (GB) / <i>ize</i> (US)	forms verb from adjective	<i>modernise, synthesize</i>
- <i>ish</i>	a bit, resembling	<i>yellowish</i> (a bit yellow)
- <i>ism</i>	activity or ideology	<i>journalism, Buddhism,</i>
- <i>ist</i>	forms personal noun from sciences	<i>geologist</i>
- <i>ity</i>	forms abstract noun from adjective	<i>uniformity</i>
- <i>ive</i>	forms adjective from verb	<i>selective</i>
- <i>less</i>	forms adjective from noun	<i>colourless</i> (without colour)
- <i>logy</i>	study, science	<i>biology</i> (life science)
- <i>ly</i>	forms adverb from adjective	<i>quickly</i> (in a quick manner)
- <i>ment</i>	forms noun from verb	<i>excitement, replacement</i>
- <i>meter</i>	instrument which measures	<i>manometer</i>
- <i>ness</i>	forms abstract noun from adjective	<i>completeness</i> (quality of being complete)
- <i>oid</i>	like, tending towards	<i>anthropoid</i> (like a man)
- <i>or</i>	see – <i>er</i>	
- <i>ous</i>	forms adjectives	<i>delicious</i>
- <i>scope</i>	instrument for seeing	<i>telescope</i>
- <i>sion</i> (see - <i>tion</i>)		
- <i>ship</i>	forms abstract nouns, especially status	<i>friendship, membership</i>
- <i>sis</i>	process, state (in medicine a diseased state)	<i>symbiosis</i>
- <i>tion</i> (- <i>sion</i>)	forms noun from verb	<i>combination</i>
- <i>ty</i> (see - <i>ity</i>)		
- <i>y</i>	forms adjective from noun or verb	<i>cloudy, foggy</i>