

GENERAL ADVICE ON SCIENTIFIC WRITING IN ENGLISH

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What appears below is neither definitive, nor exhaustive. It is intended to apply to the writing of professional scientific reviews, articles and reports (and also, therefore, to graduate training in this area). It does not apply to popular or journalistic scientific writing.

1. Equip yourself with a good dictionary (preferably from the “Oxford” stable). Do not rely entirely on spell-checkers or on internet dictionaries. The former will not (yet) tell you if you have used words out of context, or used the wrong word spelt correctly, and both carry the following risks: (i) Spelling and definitions may not apply to British Standard English (e.g. they may be for American English). (ii) Internet sources do not have to be peer reviewed, and they may simply be wrong, or incomplete.
2. In addition to the dictionary, you should also acquire (or at least look at) J. Seely, *The Oxford A-Z of Grammar and Punctuation*, Oxford University Press (2004) (a mere £5.99) and Sir Ernest Gowers, *The Complete Plain Words*, Penguin Books (1987) (£9.99). Even experienced writers use these for reference, and they will be useful to you well beyond your university career. Again, internet sources are frequently wrong, or discuss American English, or confuse American and British English. (Webster’s On-line is an excellent dictionary – unfortunately, it is a dictionary of American English.)
3. Make sure that you use words correctly and that you understand what they mean. If you are uncertain about any word, look it up! Some common errors:

To confuse *effect* (noun) and *affect* (verb). (Effect *can* be used as a verb as in “to *effect* a change” \cong “to cause a change” but its use this way is rare.)

To use *disinterested* (neutral or unbiased) in place of *uninterested* (i.e. not interested)

The use of “Meaning” or “meaning that” in place of “this means that” or “this implies that”. If you have used “meaning” as follows,

“We removed the sample meaning the chamber was empty.”

you must replace it with something like,

“We removed the sample so that the chamber was empty.”.

To confuse ...se words with ...ce words e.g.: *Practice* is a noun, *practise* is a verb. Ditto *advice* and *advise*.

“To practise as a doctor you need to advise patients. A doctor’s practice is a source of advice.”

To confuse *accuracy* or *accurate* with *precision* or *precise*. Accurate means true. Accuracy is a measure of how far something departs from the truth. Precise means repeatable, and precision is a measure of how repeatable something is. (It is probably better to use repeatable and repeatability in place of precise and precision in many cases.)

- A measurement of a quantity is usually considered to be accurate if both its systematic and random errors are demonstrably much smaller than the measurement.
- A measurement is considered to be precise if repeated measurements of the same quantity differ by much less than their magnitude. Therefore, an inaccurate measurement (with a large systematic error) can still be precise, and good precision is not proof of accuracy.

To confuse *resolution* and *sensitivity*. Resolution is a measure of the separation (e.g. in space, time, mass, or energy) at which two features (such as peaks in a spectrum) become indistinguishable. Sensitivity is the smallest change in a quantity which can be measured. For example, the resolution of an oscilloscope depends on the width of the trace, whilst its sensitivity depends on its deflection per volt.

4. Use singulars and plurals appropriately together with the correct part of the verb e.g.

The data **were** measured(the word data is plural, datum is singular)

The following phenomena **were** observed...

We **observed an** interesting phenomenon... (the word phenomena is plural, phenomenon is singular)

A number of measurements **was** taken (number is the subject here and is singular – many similar examples exist). c.f. Numbers of measurements **were** taken. On the other hand “none” can be treated as either singular or plural, using the form which fits the context best.

A common mistake is to allow the subject and the verb to drift so far apart in the sentence that you lose track of the part of the verb required. This often indicates that the sentence is too long as well:

“We made a **set** containing 30 samples from various metals with the objective of revealing differences across the periodic table which **were** subjected to positron bombardment”

The subject here is “set”, and the authors meant to imply that it was the set (of samples) which was bombarded, although what they actually say is that the

“differences across the periodic table were bombarded” which makes no sense. Correcting the verb does not help:

“We made a **set** containing 30 samples from various metals with the objective of revealing differences across the periodic table which **was** subjected to positron bombardment.”

Breaking things down into manageable pieces does:

“We made a **set** of 30 assorted metal samples which **was** subjected to positron bombardment. The objective was to reveal differences across the periodic table.”

5. Every sentence must contain a minimum of two things: A subject (something which “does”), and a verb (the “doing word” which defines what is done) e.g.

I (subject) think (verb).

If you have written something which starts with a capital letter and ends with a full stop, semicolon or colon, and which contains no verb; add one before anyone notices.

However, there are normally three things in a sentence, at least – a subject, a verb and an object (which is “done to” by the verb):

We (subject) measured (verb) the data (object).

6. Define acronyms at first use, but do not use acronyms in the title of an article. E.g.

“The use of XRD for identifying crystalline powders”, if used as a title should be “The use of X-ray diffraction for identifying crystalline powders...”. (Some people or scientific journals prefer x-ray.)

Then, at the first mention of XRD in the article do this:

The measurements involved X-ray diffraction (XRD) followed by secondary ion mass spectrometry (SIMS) and Auger electron spectroscopy (AES).

Note that

- (i) The defined acronym comes *after* the definition and is in brackets.
- (ii) The definition only contains words with capital letters if these are proper names (“Auger” was Pierre Auger, one of the discoverers of the Auger effect), or if the convention is to use a capital letter as in “X-ray”.
- (iii) There are no full stops.

7. Never use constructions such as:

“In this day and age”

“By and large”
“As such”

8. Apostrophes:

The use of contracted words (isn't, can't, won't, it's (for “it is”)) is forbidden.

With a couple of exceptions, the use of possessives should normally¹ be limited to people as in “Thompson's work shows that...,” or, occasionally, objects central to a work as in “The Sun's neutrino emission...”. They should not usually be used with inanimate objects. Therefore constructions like “... connections were made using the voltmeter's leads...” and “ the XPS instrument's spectra ...” are undesirable.

The exceptions are “its” (note: **no apostrophe**) and whose. These are useful words which can prevent repetition in the same or adjacent sentences. (Repeated words are usually considered to be clumsy in English, unless used for special effect.) Compare,

“We used a novel technique for labelling the proteins. The basis of this novel technique is the use of non-radioactive, but luminescent tracer molecules...”

with

“We used a novel technique for labelling the proteins. Its basis is the use of non-radioactive, but luminescent tracer molecules...”

or

“In order to label the proteins, we used a novel technique whose basis is the use of non-radioactive, but luminescent tracer molecules.”.

Of course, in this case one can eliminate the possessive entirely and write:

“In order to label the proteins, we used a novel technique based on the use of non-radioactive, but luminescent, tracer molecules. ...”

Also note the way the tenses are used here “We used... (we are telling our story) ...Its basis is (i.e. it is still true)”. If we had written “We used...Its basis was ...”, we would probably be implying that we do not do it that way any more. E.g.

“In order to label the proteins, we used a novel technique whose basis was the use of non-radioactive, but luminescent tracer molecules. However, this was found to be inefficient and ...”

Interestingly, the final example,

“In order to label the proteins, we used a novel technique based on the use of non-radioactive, but luminescent tracer molecules. ...”

¹ Note the splitting of the parts of the verb “to be”. To do anything else could be considered clumsy.

can be made to work either way.

9. If a typewritten sentence is more than three lines in length, and contains more than three or four commas (or other stops), you should ask yourself whether or not it is too long. The only real exception to this rule is where a list has been included. A good writing style will “set the reader up” with a relatively long sentence, for example, one containing some experimental conditions. Following this there will be a short sentence describing purpose or consequence. E.g.

Very bad:

Following a 7 hour heating cycle, ramping the temperature from room temperature to 600 °C once per hour, the instrument was allowed to cool for a further two hours before measurements were taken, meaning the conditions were stable and accurate data could be obtained.

Comment: It is clear that the writer has not said what they meant to say, and understands neither the correct (scientific) meaning of “accurate” nor the use of “meaning”.

Better:

The instrument was subjected to an hourly heating cycle in which the temperature was varied from 25 °C to 600 °C and back. This was maintained for 7 hours, and then the instrument was allowed to cool for a further two hours before measurements were taken. As a result, the conditions were stable and *precise* data could be obtained.

*Comment: The sentences are shorter. The information given is more complete. The incorrect use of “meaning” and “accurate” has been eliminated. To avoid confusion, **reproducible** could be used in place of **precise**.”*

However, this is not to say that an entire work should consist of alternating long and short sentences – that would be boring.

10. Units must be separated from magnitudes by a non-breaking space (shift-ctrl-spacebar in MS Word™). e.g.

75 mm not 75mm
300 ms⁻² not 300ms⁻²

Note that the hyphen used as a minus sign should also be non-breaking (shift-ctrl-minus. (To superscript and subscript from the keyboard use shift-ctrl+ and ctrl+ respectively.)

11. Splitting the infinitive is perfectly acceptable in English. The archetypal, “To boldly go”, is fine - although, “To go boldly”, might have sounded better. Infinitives may be split to increase the readability of a sentence, and to remove ambiguity (see Sir Ernest Gowers, “The Complete Plain Words”), or just because it sounds better to do so. Do not do it just because you can though. If the infinitive is split, it generally straddles an

adverb (e.g. “boldly”). It should never be separated by an adverbial clause. For example, “to boldly and with full appreciation of the consequences go” is awful.

12. Citing references: All high quality² scientific writing acknowledges the work of others, usually by means of references. There are several accepted ways of doing this in scientific writing, and the style required varies from one journal to another. The most common way is to use a numbered reference list collated at the end of the work, and to make reference to the list by means of numbers in the text. Sometimes it is also appropriate to quote the authors’ names (or the first named author followed by “et al.” if there are more than 2). The numbers are usually enclosed in square brackets or superscripted or both. The way the information is presented in the list also varies considerably according to the journal. You simply have to use the style you are requested to use. For example:

As Jenkins et al. show (*or: have shown*), the magnitude of the effect varies according to the experimental conditions [1]. Elsewhere [2] we demonstrate (*or: we have demonstrated*) a parabolic dependence upon temperature. In recent reviews of associated phenomena [3,4] other authors conclude that ...”

Then, at the end of the article there would be a numbered list:

- [1] A. D. Jenkins, H. Y. Gao, P. G. Wodehouse and B. F. Strickland, *Int. J. Interesting Phenom.* **25** (2003) 336-342.
- [2] T. P. McKenna and M. G. Dowsett, *J. Electrochem. Soc.* **231** (2005) 661-237
- [3] S. T. Rinderaft and A. Sailin-Bote in *Collected Observations of Several Scientists*, ed. S. T. Lingalldecredit, Coronary Books, New York (2002) Ch 7.
- [4] O. B. Nicetome and N. O. Tachance, *A Long Book on this Subject*, Smith and Jones, Chichester UK (2006).

Note that items [1] and [2] are in journals and the reference runs as follows:

List of authors, *standard abbreviated or full journal title (especially if you do not know what the correct abbreviation is)* **volume number** (year) start page-end page.

Items [4] and [5] are books, in which case the information which must be given is:

Author list, *Title of Book*, ed(s). Editor list (if any), Publishers, Location of Publishers, (year of publication) Chapter or page reference if appropriate. Today, the ISBN might also be given.

Never cite Wikipedia or similar sources as a reference. They might be useful as pointers in preliminary research but you must always find a proper scientifically valid reference later. Individual items from such web sources vary from excellent to complete nonsense. This is because they are not formally peer reviewed. Since they cannot be trusted, they must not be used. A similar rule should be applied to almost any website.

² Note in passing that it is better not to use “quality” on its own as an adjective. In scientific writing “Quality people, quality cars”, would be too ambiguous, and should be “High quality people, high quality cars” (presumably).

13. Diagrams. Lifting diagrams from any source without attribution is just as much an act of plagiarism as copying the text and using it for your own. In professional scientific writing one must seek the permission of the publishers of an article in order to use a diagram therein, even when one intends to make a full acknowledgement. It is often more straight-forward to produce one's own figures. There are many excellent tools for doing this (including the drawing package embedded in MS Word™), and it is a really useful skill to learn.
14. Prepositions are words which, amongst other things, help provide context in space and time. E.g. prepositional verbs:

coming **from**, going **to**, surprised **by**, decide **on**, compare **with** / compare **to**
(these have different meanings)

also prepositional phrases:

until night, **during** the experiment, etc.

It is a common mistake to associate the wrong preposition with the verb in prepositional verbs. Much of the time it is relatively unimportant, but scientific writing demands extra care and accuracy:

Bad: "The sphere is centred **around** the origin"

Good: "The sphere is centred **on** the origin"

Your dictionary will give examples using the correct prepositions.

15. Less and fewer. These are often misused, following the widespread ignorance of politicians and broadcasters. Less (like more) refers to degree. Fewer refers to numbers. Thus, if I have 20 samples and I needed 30, then I have "**fewer** samples than I need". If I cannot get a sufficiently precise average value then I have "**less** data than I need" or "too **few** measurements".

16. Conjuncts and conjunctions.

Conjunctions (and, but, or, because etc.) are used to join parts of sentences together. I used to be taught (in defiance of the King James' version of the Bible) that one should not start a sentence with a conjunction. However, there is no strict grammatical rule to this effect, and "because" is often so used. Nevertheless, in scientific writing, it is hard to see why one would need to start a sentence with "And ..." or "But ...".

Conjuncts (however, nevertheless, moreover etc.) are mostly used to relate sentences to one another. You should not use them as if they were conjunctions; however, if you do place them in the body of a sentence, rather than at the start, they should normally be preceded by a semicolon, not a comma. You might also ask whether the sentence was becoming too long and perhaps add a full stop:

"It is unusual to observe this emission at such temperatures. However, if a large electric field is present as well, we find that Cs⁺ emission occurs routinely."

17. Tenses and related issues:

Selection of the correct tense causes problems for most of us from time to time. It is generally not sufficient to rely on instinct until you have had considerable writing experience. This is because much of our use of tenses comes from speech, where we all tend to adopt forms we have absorbed from people around us, especially our parents and peers. Perhaps the best way through the maze is to ask oneself a series of, “Am I ...” questions, as follows:

Am I reporting something that I did?

Use the *first person plural*³ (we) with the *simple past tense*:

“We **connected** the coil to the power supply using superconducting wire.”

“We **made** three sets of samples with increasing concentrations.”

or use the *passive voice* with the *simple past tense*:

“The coil **was connected** to the power supply using superconducting wire.”

“Three sets of samples with increasing concentrations **were made**.”

It is useful to mix these two forms to avoid the tedious repetition of “we”.

Am I reporting something that I did whilst something else was happening?

This is a surprisingly frequent requirement in scientific reporting – one wants to stress that two (or more) actions or events must be related in order for things to proceed. Usually this is done using a construction based on “while”. The “while” tense is *past continuous* and the thing that is “going on while” is in the *simple past tense*:

“While the instrument **was being** baked, we **made** further samples”

Am I reporting something which carried on for a while and then stopped?

Use the *past continuous* tense again:

“Sir J. J. Thompson **was working** on this problem in 1912”

“We **were recording** the data when the star exploded”

Am I reporting something which started some time ago and is still going on?

³ In the early days of scientific reporting, it was acceptable to write in the first person (e.g. “I did the experiment.”). For example, in 1912 Sir J. J. Thompson wrote, “In my ‘Conduction of Electricity through Gases’ it is shown that...” (*Phil. Mag. S. 6. 23* (1912) 2). Were he writing today, he would probably put “In the author’s ‘Conduction of ...’”.

Use the *present perfect* tense:

“The human race **has used** lead as an engineering and artistic material for around 10,000 years.”

Am I reporting measurements/results, or generally known values/phenomena which are still believed to be true?

Use the *simple present* tense:

“The value of pi **is** approximately 3.14159.”

Am I reporting measurements or results which I have shown are false, or which are no longer believed to be true, or where a mistake was made?

Use the *simple past* tense to report the old/incorrect value, and the *simple present* tense to confirm the new one:

“The ancient Egyptians **found** that the ratio of the circumference of a circle to its diameter **was** 3. However, we now know that the value of Pi **is** approximately 3.14159.”

Alternatively, the correction can be given using “have” (*future perfect* tense):

“The potential (we) **used was** 2.7 mV, but later measurements showed that it **should have been** 3.4 mV”

Am I discussing (as opposed to presenting/reporting) the current view of some data?

Use the *simple present* tense:

“Our measurements of the binary system **show** that the more massive star is absorbing mass from its companion”

Am I setting up an imaginary situation or an hypothesis (what if? ...)?

You can use the *subjunctive mood* (I were, he/she/it were, we were, they were):

“If the data **were** to be taken at face value, we might expect all the carbon dioxide to be released.”

Am I summarizing my work in the conclusions?

Use the *present perfect continuous* tense:

“Our measurements of the binary system **have shown** that the more massive star is absorbing mass from its companion”

Am I describing what I will do next?

“In future work we **will concentrate** on measuring the speed of light to a higher precision”
(*Simple future* tense.)

“By 2008 we **will have completed** these measurements”
(*Future perfect* tense – implies or predicts that an action will be over some time in the future)

“We **will be making** these measurements for several years”
(*Future continuous* tense – implies that action will last for some time.)”

18. Punctuation. Perhaps this is the most difficult part of writing. One can only give very general guidelines and then refer the reader to the Oxford A-Z (not the street-maps), or the dictionary.

Commas are the most abused punctuation marks. They are used to break up sentences and to delimit items in a list, but they should not be strewn around like confetti to create over-long sentences.

Semicolons are used to delimit lists where the individual items are long, or where they contain commas. They are also used to break sentences into two or more parts where the parts themselves could stand as sentences, but where there is an association of ideas which the author wishes to retain.

“We would not normally consider leaving the beam scanning over the sample for this length of time; in this case it was necessary to obtain a statistically useful image.”

Colons are used to precede a list or a quotation. A comma may also be used for the latter purpose.

Question mark: Used very occasionally and for effect. Sometimes used to provoke thought as in the article title:

“What can corrosion potential tell us about the state of the metal surface?”

Exclamation mark: Never (?) used (except to signify the factorial, e.g. 6!).

Quotation marks: Must be used to enclose a direct quote from a source. The source must also be given.

19. Rules and non rules:

There is no rule of grammar which says that you may not end a sentence with a preposition. It is a question of what reads the best, and what expresses the meaning accurately. It can also be a question of style.

Similarly, there is no rule which says you must not split infinitives – split away *if* it helps improve the clarity and removes ambiguity.

Words ending in ize or ise: It is not true that “ize” is American, whereas “ise” is English. There are some words such as “surprise” where, because of the origins of the word, ize is incorrect (Joanna Clarke notwithstanding). In many cases ise and ize are both accepted (but be consistent). In a few, ize might be preferred. If in doubt – look it up in a proper dictionary!

However, beware. Just like you, people who mark and assess your work, or referees and editors of journals, have their own ideas of what constitutes “correct” English. If you can justify your choice by pointing to a reputable source, then you are safe (ish).

20. Tautology is the undesirable repetition of a sentiment or a statement. For example,

“What appears below is neither definitive, nor exhaustive. It does not cover everything.”

When I say that the content is “not exhaustive” this means exactly the same as “It does not cover everything” so an entire sentence is redundant.

Typically, an inexperienced writer who has not written very much (see!) runs to 3 tautologies per typewritten page – so watch out!

Page intentionally left blank for tautology

21. And finally...

The main objective of scientific writing is to provide a clear, concise, and accurate account of: progress in a field, the development and application of a theory or model, or an experiment and its results.

Always use the shortest word which fully and accurately expresses your meaning, but try to avoid repeating the same word in the same or successive sentences.

Do not make sentences too long, but try to develop a varied pace in your writing by mixing short and long sentences appropriately.

Read your work aloud – to yourself, or to friends. Record it and play it back if necessary. The ear picks up mistakes which the eye misses.

Leave time to put the work aside (a few days) so that you can read it with a fresh eye.