

Scientific English as a Foreign Language

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Abstract

These lessons in Scientific English were written for the benefit of our colleagues at the Ecole Polytechnic Fédérale de Lausanne in Switzerland, where we were researchers from 1994-1999. As native English speakers, we were besieged by non-native speakers asking for help with their manuscripts, as many as five requests per week.

Each language group is susceptible to predictable mistakes in English; these lessons were written for our colleagues: French- and German-speaking scientists with a solid foundation in English. They appear in no particular order, having been prompted by typical mistakes that we observed from week to week.

Most lessons are followed by a quiz and a humorous quotation. In their original format, the lessons were emailed with blank spaces in the quizzes so that the subscribers – the list grew from a dozen to seven hundred – could test their knowledge before checking their answers at a website. In 2003, the web pages were migrated to http://users.wpi.edu/~nab/sci_eng/. And in 2007, Scott Cogan (Université de Franche-Comté, Besançon, France) kindly transformed them into a LaTeX file, to which we added a table of contents and this abstract.

Although we are now busy with physics education and research in the United States, Fred still occasionally corrects manuscripts and dissertations. You may contact him at flh@wpi.edu.

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1 Around, About, Approximately

Please don't overuse "about" or "around" in your papers to mean "approximately". "About" and "around" have many other meanings than "approximately", a few of which I have listed below. Use them as variety and as alternatives to "approximately", but remember that "approximately" is really what you usually want to express.

About

1. of; concerning; in regard to: *instructions about the work; a book about the Civil War.*
2. connected or associated with: *There was an air of mystery about him.*
3. near; close to: *a man about my height; about six o'clock.*
4. in or somewhere near: *He is about the house.*
5. on every side of; around: *the railing about the excavation.*
6. on or near (one's person) : *They lost all they had about them.*
7. so as to be of use to: *Keep your wits about y.*
8. on the verge or point of (usually fol. by an infinitive) : *about to leave.*
9. here or there; in or on: *to wander about the old castle.*
10. concerned with; engaged in doing: *Tell me what it's about. Bring me the other book while you're about it.*

Around

1. in a circle, ring, or the like; so as to surround a person, group, thing, etc.: *The crowd gathered around.*
2. on all sides; about: *His land is fenced all around.*
3. in all directions from a center or point of reference: *He owns the land for miles around.*
4. in a region or area neighboring a place: *all the country around.*
5. in circumference: *The tree was 40 inches around.*
6. in a circular or rounded course: *to fly around and around.*
7. through a sequence or series, as of places or persons: *to show someone around.*

Approximate

1. near or approaching a certain state, condition, goal, or standard.
2. nearly exact; not perfectly accurate or correct: *The approximate time was 10 o'clock.*
3. near; close together.
4. very similar; nearly identical.
transitive verb
5. to come near to; approach closely to: *to approximate an ideal.*
6. to estimate: *We approximated the distance at three miles.*
7. to simulate; imitate closely: *The motions of the stars can be approximated in a planetarium.*
8. to bring near.

Try putting the three words in the sentences below.

1. The moat is **around, about** (2 possibilities) the castle.
2. I'm **about** done with the experiment.
3. The value of the modulus is **approximately** 100 MPa.
4. The tools are scattered **around, about** (2 possibilities) the lab.
5. The book is **about** dislocation theory.
6. The precision of the measurement is **approximately** ± 0.001 Hz.
7. Please show our visitor **about** Europe.
8. Please show our visitor **around** the labs.

(These last to distinguish the difference between "about" and "around".)

9. It's **approximately** 50cm in circumference.
10. It's 50 cm **around**.

The first law of Newton I sing
My voice has a relevant ring:
"An object left free
Of hassles will be
Engrossed in just doing its thing."

-E.H. Green

2 Locate and Localize

To LOCATE is to find or to be situated. To LOCALIZE is to confine something to a specific area.

1. Where are my glasses? I can't **locate** them.
2. I need to clean my apartment. First I'll **localize** the mess into a closet.
3. I need to make some copies. Where are the copy machines **located**?
4. Round up the horses and **localize** them in the corral.
5. The inclusions in the sample were **located** by optical microscopy.
6. In a 2D gas, the electrons are **localized** by the change in potential.
7. I would like to visit you. Where is your lab **located**?

On a merry-go-round in the night,
Coriolis was shaken with fright,
Despite how he walked,
'Twas like he was stalked,
By some fiend always pushing him right.
-D. Morin et al.

3 Borrow and Loan

Non-native speakers often get these confused. Remember them in the following way:

- You borrow money from the bank. {SUBJECT, VERB, DIRECT OBJECT, PREP. PHRASE}
Or, alternatively: You borrow money. {SUBJECT, VERB, DIRECT OBJECT}
But NOT: You borrow the bank money. {SUBJECT, VERB, INDIRECT OBJ., DIRECT OBJ.}
- The bank loans money to you. {SUBJECT, VERB, DIRECT OBJECT, PREP. PHRASE}
Or, alternatively: The bank loans money. {SUBJECT, VERB, DIRECT OBJECT}
Or: The bank loans you money. {SUBJ, VERB, INDIR. OBJ, DIR.OBJ}

Note that the construction SUBJECT, VERB, IND. OBJ, DIR. OBJ is allowed for "loan" but forbidden for "borrow". Here are some exercises:

1. I forgot my pen. Can you **loan yours** to me?
2. I forgot my pen. Can you **loan me** yours?
3. I forgot my pen. Can I **borrow yours**?
4. I forgot my pen. Can I **borrow one** from you?
5. In general, I always **borrow** pens from my colleagues.
6. And you always **loan me** yours.

Miss Farad was pretty and sensual
And charged to a reckless potential;
But a rascal named Ohm
Conducted her home—
Her decline was, alas, exponential.
-A.P. French

4 Teach and Learn

These verbs are sometimes confused by on-native speakers. In the "borrow" and "loan" lesson, the person who has the desired goods is the loaner, the person who wants the desired thing is the borrower. Here, the teacher is the one who already knows the information, the learner the one who receives the information.

Remember the relationship to the active person in your sentence (noun), the information that is being taught or learned (direct object), and the person who is receiving or giving the information (indirect object). Therefore:

M. Tapis taught me French. NOUN, VERB, IND.OBJ., DIR.OBJ.

I learned French from M. Tapis. NOUN, VERB, DIR.OBJ, IND.OBJ.

I don't want to learn business ethics from M. Tapis. NOUN,VERB,DIR.OBJ,IND.OBJ.

Here's some for you to try.

1. I **learned** physics from Prof. Benoit.
2. Prof. Benoit **teaches** physics to the students. Are both verbs possible in the following?
3. I _____ physics at EPFL. **YES**
4. I _____ myself Windows 95. **NO**
5. I _____ it all by myself. **YES**

While you are correct to write: "I teach physics at EPFL", "I learn physics at EPFL", "I learn it all by myself", "I teach it all by myself", or "I teach myself Windows 95", you may not write "I learn myself Windows 95." This latter sentence implies that the subject (I) is both the teacher and the learner, which makes no sense. If the subject already knew Windows 95, there would be no reason to learn it. In "I teach myself Windows 95", one has the impression that the learner (myself) is making use of a help file or trial-and-error, so this sentence is OK.

Interestingly, one CAN write "I learn Win95 by myself." or better, "I am learning Win95 by myself", and this is equivalent to "I teach myself Win95." This small change in structure, from "myself = reflexive object" to "by myself = prepositional phrase", shifts the emphasis to the idea that the subject is alone in his or her pursuit of Win95 knowledge, that is, is not requesting any outside assistance.

There once was a fly on the wall
I wonder why it didn't fall
Because its feet stuck
Or was it just luck
Or does gravity miss things so small?
-R.D. Cowan

5 Elaborate and Fabricate

PLEASE don't ever write "The sample was elaborated....." To "elaborate" in English means the following:

ELABORATE (elaborated, elaborating, elaborately, elaborateness, elaborative, elaborator, elaboration):

1. perfected, painstaking.
2. ornate.
3. refine, improve.

What you typically want to express is "The sample was fabricated....." FABRICATE (fabricated, fabricating, fabricative, fabricator, fabrication):

1. to make by art or skill and labor; construct: *The finest craftspeople fabricated this clock.*
2. to make by assembling parts or sections.
3. to devise or invent (a legend, lie, etc.)
4. to fake; forge (a document, signature, etc.) — Syn.1. See manufacture.

As you can see, the difference in meaning is great. Try these.

1. The sample was **fabricated** by sputter deposition.
2. This is a very **elaborate** experiment. It will take many weeks.
3. The work **elaborated** the procedure at length.
4. The last stage of sample **fabrication** was accomplished by annealing.
5. The elaborate sample **fabrication** procedure was the result of many months of hard effort.

A Brief History of Gravity

It filled Galileo with mirth
To watch his two rocks fall to Earth.
He gladly proclaimed,
"Their rates are the same,
And quite independent of girth!"
Then Newton announced in due course
His own law of gravity's force:
"It goes, I declare,
As the inverted square
Of the distance from object to source."
But remarkably, Einstein's equation
Succeeds to describe gravitation
As spacetime that's curved,

And it's this that will serve
As the planet's unique motivation.
Yet the end of the story's not written;
By a new way of thinking we're smitten.
We twist and turn,
Attempting to learn
The Superstring Theory of Witten!
-B. Elliot

6 Make and Do

"Make" and "do" are difficult for non-native speakers because often you use only one verb - e.g. "faire", in French and "machen" in German - to express the meanings of both "make" and "do".

It's impossible for me to list all of the different ways that "make" and "do" are used. "Make" is used more frequently in the sense of fabrication, or of successfully achieving a goal. "Do" is more often used for the sense of performing a task or used as an auxiliary verb. Here are some examples of the most common usages.

- Meeting someone at a party: "What do you do?" = "What is your profession?" "What do you make?" = "How much money do you earn?"
- Advent: "I made my Christmas cards." = "I designed and printed my Christmas cards."
- "I did my Christmas cards." = "I wrote and mailed my Christmas cards."
- Traveling: "Did you make your train?" = "Did you catch your train?"
- Between colleagues: "Do you need help?"....."Yes, I do."

Now, here's a test- Two LPM1 students are talking about their research project:

Student 1, "Have you **made** the sample?"

Student 2, "No, I'll **make** it tomorrow, then I'll **do** the experiment."

Student 1, "If you **do** the experiment, **do** you want me to write the lab report?"

Student 2, "Yes, I **do**. I hope that we can **make** Professor Benoit happy."

Student 1, "It would **make** me happy if we **do**."

While watching a cannonball's motion,
Galileo conceived of the notion
That natural laws,
Not mystical Cause,
Ruled the physical world's locomotion.

Though its own view was mostly confused,
The Church was not greatly amused
With this flaunting of Deo
By old Galileo
And ordered it quickly defused.
In spite of the Vatican's dissuasion
Galileo still rose to the occasion.
Though once deemed heretical,
He proved more prophetic
Than those of a clerical persuasion.
-M.J. Murphy

7 Experience and Experiment

An experiment is what you do to investigate something. It is the process by which you learn something. Also, please don't use the word "experiment" to refer to the instrumentation with which you do the experiment. You can say "experimental setup", but the experiment is the *PROCEDURE* you use to test a hypothesis.

An experience is something that happens to you that is memorable in some way. Here are some of the definitions.

Experience -noun

1. a particular instance of personally encountering or undergoing something: *My encounter with the bear in the woods was a frightening experience.*
2. the process or fact of personally observing, encountering, or undergoing something: *business experience.*
3. the observing, encountering, or undergoing of things generally as they occur in the course of time: *to learn from experience; the range of human experience.*
4. knowledge or practical wisdom gained from what one has observed, encountered, or undergone: *a man of experience.*
5. Philos. the totality of the cognitions given by perception; all that is perceived, understood, and remembered.

-transitive verb

6. to have experience of; meet with; undergo; feel: *to experience nausea.*
7. to learn by experience.
8. experience religion, to undergo a spiritual conversion by which one gains or regains faith in God.

Experiment

1. a test, trial, or tentative procedure; an act or operation for the purpose of discovering something unknown or of testing a principle, supposition, etc.: *a chemical experiment; a teaching experiment; an experiment in living.*
2. the conducting of such operations; experimentation: *a product that is the result of long experiment.*

To summarize, experiences are personal, and experiments are scientific. Test your knowledge!

1. I went helicopter skiing last year. What an **experience**!
2. The **experiment** indicates that the modulus of a single nanotube is approximately 1 TPa.
3. The sample is not fixed rigidly in place. Why don't you **experiment** with different glues?

4. I have little **experience** with research. I'm still an undergraduate.

There was a young fellow named Cole
Who ventured too near a black hole.
His dv by dt
Was quite wonderous to see
But now all that's left is his soul.

8 Less and Fewer

Many native speakers mix these up. You shouldn't.

"Less" is used to express a smaller quantity of something: *Less wine was produced this year in Switzerland.*

"Fewer" means a smaller number of units: *Fewer bottles of wine were produced this year in Switzerland.*

In other words, "less" can be thought of as the appropriate word for continuum descriptions and "fewer" for quantum descriptions.

Try it!

1. This atomically-resolved image of the surface of graphite measuring 10x10 nm has **fewer** atoms in it than the 20x20nm image.
2. We have no **fewer** than 10 torsional pendulums.
3. "Let's apply **less** voltage and see what happens."
4. "Downloading images from Netscape is easy today. There's **less** traffic, that is, **fewer** requests."
5. Who has **less** time, the students or the professors?

A friend who's in liquor production
Owns a still of astounding construction.
The alcohol boils
Through old magnet coils;
She says that it's "proof by induction."

-D.M. Smith

9 The

I'm sure you know the meaning of "the". But its usage is slightly different than "le, la, les", or "der, die, das", or the equivalent in other languages. According to the American Heritage Dictionary, one uses "the" in the following ways:

1. Before singular or plural nouns and noun phrases that denote particular specified people or things.
2. Before a singular noun, making it generic: '*the human arm.*'
3. Before a noun, and generally stressed, emphasizing its uniqueness or prominence: '*That's THE show to see this year.*'
4. Before a title of rank or office, designating its holder: '*The President arrives tomorrow.*'
5. Before an adjective, extending it to signify a class and giving it the function of a noun: '*the rich, the beautiful.*'
6. Before an adjective used absolutely: '*the finest we have to offer.*'
7. Before a present participle, signifying the action in the abstract: '*the weaving of rugs.*'
8. Before a noun, with the force of 'per': '*at a dollar the box.*'

How would you fill in these blanks?....or would you?

1. **The** microscope in the corner is broken.
2. Optical microscopes have resolutions of about one micron.
3. **The** scanning probe microscope supercedes **the** optical limit.
4. Scanning probe microscopes can do better than that.
5. I haven't read such a good paper in a long time. It's **the** publication of the year.
6. Please have a look at **the** publication that appeared yesterday.
7. Please read publications.
8. President Badoux visited our lab yesterday.
9. **The** President visited our lab yesterday.
10. **The** educated are responsible voters.
11. Educated people are responsible voters.
12. It's **the** best work we can do.
13. Better work is impossible.
14. **The** imaging of surfaces at the nanometer scale is now possible.
15. We can make images of surfaces at the nanometer scale.

16. My consulting rates are \$1000 **the** day.
17. My consulting rages are \$1000 per day.
18. **The** day that I charge you less than that is **the** day that Hell freezes over.

There once was a girl named Irene,
who lived on distilled kerosene.
But she started absorbin'
A new hydrocarbon,
And since then has never benzene!

- K. Kiger

10 Much and Many

Examples:

1. There are many people here.
2. You drank *many* glasses of wine last night.
3. You drank *too many* glasses of wine last night.
4. You didn't drink *many* glasses of wine last night.
5. You didn't drink *too many* glasses of wine last night.
6. There is *much* discussion about that topic.
7. I had *much* wine last night.
8. I had *too much* wine last night.
9. I didn't have *much* wine last night.
10. I didn't have *too much* wine last night.

Like "less&fewer", "much&many" describe quantities of things. Proper usage: "many" for discrete objects, such as people or glasses, or "much" for a continuum of something such as discussion or wine.

"Too" is used as an amplifier to suggest that something is beyond the normally expected limits or is extreme. In the case of wine, if I drank much wine, then I got drunk, but if I drank too much wine, then I was very drunk, and I feel terrible today.

"Not much" means "a little". "Not many" means "a few". "Not too much" means "some", but not beyond the expected limit. "Not too many" means "several", but no more than usual.

1. I have **many** things to do.
2. I have **much** to do.
3. One can't have **too much** fun (extreme case).
4. But one can have **too many** problems (extreme case).
5. "Are there **many** samples to be tested?" "No, **not many** (a few)." or... "No, **not too many** (several)."
6. "Would you like some coffee?" "Yes, but please **not too much** (some). I'm sensitive to caffeine." or...
7. "Yes, but please **not much** (only a little). I'm extremely sensitive to caffeine."

The thermo exam was quite near-o,
And he thought everything was quite clear-o;
"Why study this junk I'm sure I won't flunk."
But they gave him an Absolute Zero.

- K.R. Devicci

11 Improve, Ameliorate, Better

"To improve" is a general verb. "To ameliorate" has the specific meaning of to improve something that is presently bad. One does not use "ameliorate" in the sense of making a good thing better. The Random House CD-ROM Dictionary puts it this way:

TO IMPROVE:

Syn. 1. amend, emend. IMPROVE, AMELIORATE, BETTER imply bringing to a more desirable state.

IMPROVE usually implies remedying a lack or a felt need: to improve a process, oneself (as by gaining more knowledge).

AMELIORATE, a formal word, implies improving oppressive, unjust, or difficult conditions: to ameliorate working conditions.

To BETTER is to improve conditions which, though not bad, are unsatisfying: to better an attempt, oneself (gain a higher salary).

Try these. Sometimes more than one word (improve, better, ameliorate) is correct. The word in parentheses is less common, but still correct.

1. "This signal is awful. I shall try to **improve (better)** the signal-to-noise."
2. "My signal-to-noise is pretty good, but I think that I can **improve (better)** it still more."
3. "I feel sorry for people in North Korea. I wish I could **improve (ameliorate)** their situation."
4. "We can **improve (better)** the paper by adding more data."
5. "By adding a vacuum layer we can **improve (better)** the terrible thermal insulation."
6. "The proposal lacks substance. How can we **improve (better)** it?"
7. "The research environment at Company X is stultifying. Don't work there until the conditions **improve (ameliorate)**."

A couple of young guys in Boulder,
Cooled their gas cloud down colder and colder.
Then with much exhortation,
They hit Bose Condensation,
And beat out their rivals (much older).

-J.P. Dowling

12 Remember and Remind

1. "Do you remember when you first started working at EPFL?"
2. "Yes, I remember. It was February 1994."
3. "Tomorrow I'll be very busy. Can you remind me to call about the conference?"
4. "Yes, I'll remind you."

To *remember* is to recall a thought within oneself. To *remind* is to help someone else remember something. So you must be careful about who is the subject and who is the object- if they agree, it's remember, if they don't agree it's remind.

In the examples above, in #1 and #2, the discussion concerns what's happening within the head of speaker #2. In #3 and #4, speaker 4 is going to help speaker #3 remember to do something. Here are some examples for you to try:

1. Tomorrow, I must **remember** to go to the doctor for my back.
2. It's very important. Would you please **remind** me?
3. If I don't **remember**, I'll never be able to get another appointment.
4. I must **remind** you to get your lab reports to me on time.
5. If you don't **remember**, your grade will be low.
6. But **remind** me to look at them this week.

A proton once said, "I'll fulfill
My long-term belief in free will.
Though theorists (may) say
That I ought to decay
I'm damned if I think that I will."

-D. Halliday

13 Verb Tenses

Tenses are difficult in English. Put in the verb "to work" in the following sentences. Try to use the most appropriate verb tense.

1. He is a good pupil: he always works seriously.
2. What's he doing now? He **is working**.
3. He **did not work** at all last week.
4. What are you going to do now? I **am going to work**.
5. This result is good: you **worked** well today.
6. He **had never worked** before he left school.
7. I **worked** while you were sleeping.
8. I'll pay you more when you **work** more.
9. You **would work** more efficiently if you were more attentive.
10. **Work!** Don't sleep!
11. I **would have certainly worked** more if I had been encouraged.
12. They told me not **to work** too hard during the first week.
13. I think **working** for this firm is not very exciting.
14. What are you doing this afternoon? I **shall work**.
15. He **doesn't work**, does he?
16. You needn't **work** if you don't like it.
17. I would rather **work** than stay at home.
18. I wonder why my parents always want me **to work**.
19. It's no use **working** if it doesn't interest you.
20. He went on **working** until he was too tired to continue.
21. I used **to work** twelve hours a day before the war.
22. I **worked** a lot today. I'm going to watch television now.
23. **Did he work** last weekend?
24. You could **have worked** better if you had wanted to.
25. He **has worked** two months for the same firm and he intends to go on working there.

This exercise was taken from "Testez votre anglais", Bordas, Paris, 1987.

A university creative writing class
was asked to write a concise essay
containing these four elements:
religion, royalty, sex, and mystery.

The prize-winning essay read,
"My God," said the Queen.
"I'm pregnant. I wonder who did it?"
-author unknown

14 Say and Tell

It is hard for non-native speakers to know when to use "say" as opposed to "tell". Sometimes they are exact synonyms, and sometimes only one may be properly used. There are many different definitions of "say & tell"- 17 for "say" and 23 for "tell". I can give you two clues: 1) you normally "tell" jokes and stories, not "say" them; 2) when "say" and "tell" are synonyms, "tell" usually takes an indirect object: "He told me that the sample was ready." or "He said that the sample was ready." or "He said to me that the sample was ready." But don't use: "He told that the sample was ready." (no me, that is, no indirect object)

Try these:

1. Last week you **said** "No", yesterday you **said** "Yes". What will you **say** tomorrow?
2. They **told** us a great story.
3. Didn't he **tell** you that?
4. Didn't he **say** that?
5. Didn't he **say** that to you?
6. When you were young, did your parents **tell** you fairy tales?
7. In a presentation, it is useful to **tell** a joke (to the audience) in order to keep people's attention.

An electron, while traveling in space,
Met a positron there "face-to-face."
The electron then sighed,
At the sight of his bride
And they "died" in a loving embrace.

-W. Rolnick

15 Prepositions

Prepositions are difficult in every language. For native French speakers, English and German can be challenging, because the prepositions in English and German can greatly influence the sense of a sentence. For example:

He looks for his father. He looks like his father. He looks at his father. He looks after his father.

The four sentences above have different meanings, just by changing the preposition. Sadly, I can't give you any rules or guidelines as to when to use one preposition or the other. You must learn by paying attention to usage. Try these. (Sometimes no preposition is necessary.)

1. Yield in metals is associated **with** dislocation motion.
2. Please subscribe **to** the journal.
3. He told me that my assumptions were bad.
4. He said **to** me that my assumptions were bad.
5. Kekulé dreamt **about** the chemical structure of benzene.
6. After annealing, the sample was taken **out** of the oven.
7. After annealing, the sample was taken **from** the oven.
8. I will participate **in** the discussion.
9. The adsorbates preferentially bind **to** the steps.
10. **At** the steps, the work function is changed due to a surface dipole moment.

Two photons, close-coupled at start,
Flew several parsecs apart.
Said one, in distress,
"What you're forced to express
Removes any choice on my part."

-D. Halliday

16 Allow

One of the most frequent errors from French and German speakers is:

"The instrument allows to measure..."

"Allow" is usually used as a transitive verb, which means that it takes a direct object.

The phrase above should read:

"The instrument allows one (or us, the student, the researcher, you, etc.) to measure..."

"Allow" is more difficult than some purely transitive verbs, in that sometimes it is transitive and sometimes not. Here are the definitions of "allow" from the Random House CD-ROM Dictionary:

ALLOW:

- transitive

1. to give permission to or for; permit: to allow a student to be absent; *No swimming allowed.*
2. to let have; give as one's share; grant as one's right: *to allow a person \$100 for expenses.*
3. to permit by neglect, oversight, or the like: *to allow a door to remain open.*
4. to admit; acknowledge; concede: *to allow a claim.*
5. to take into consideration, as by adding or subtracting; set apart: *to allow an hour for changing trains.*
6. Older Use. to say; think.
7. Archaic. to approve; sanction.
— -intransitive
8. 8. to permit something to happen or to exist; admit (often fol. by of) : *to spend more than one's budget allows; a premise that allows of only one conclusion.*

Try these excercises.

1. I can't go on vacation that week. My boss won't **allow me**.
2. In Paris, it's best **to allow** two hours to get from Gare de Lyon to Gare de Nord.
3. This procedure **allows one** to replicate DNA.
4. I will **allow you** to give me the report a few days late.
5. No late abstracts will be **allowed**.

An electron is sure hard to please.
When spread out, it sometimes will freeze.
Though agoraphobic,
It's still claustrophobic,
And runs off when put in a squeeze.

-D. Morin et al.

17 Apostrophes

Definition (from Random House Unabridged CD-ROM Dictionary): the sign (') , as used: to indicate the omission of one or more letters in a word, whether unpronounced, as in o'er for over, or pronounced, as in gov't for government; to indicate the possessive case, as in man's; or to indicate plurals of abbreviations and symbols, as in several M.D.'s, 3's.

Note that when a word ends in "s", the apostrophe (indicating possession) is after the "s". Example: the house belonging to John Smith is John Smith's house; but the house belonging to all of the Smiths is the Smiths' house.

Also, in American English, one uses an apostrophe to indicate plural forms of abbreviations (shortened words), but not plural forms of acronyms (when the first letters of a long name have been grouped to form a "word"). Example: There are two ETHs in Switzerland which confer Ph.D.'s. I have found no counsel as to what to do if one has a possessive plural abbreviation. My own choice would be to say: "The Ph.D.'s careers..." (that is, the many careers of the many people who have Ph.D.'s.) In contrast, "The Ph.D.'s' careers...." or "The Ph.D.s' careers...." look odd.

In British English, abbreviations are not punctuated. So the American "Dr." becomes "Dr" in British. Therefore the plural would be "Dr.'s" in American and "Drs" in British. The possessive plurals would be "Dr.'s" in American and "Drs'" in British. Certainly British is clearer in this case.

1. What is the difference between "Lausanne Sharks win" and "Lausanne Sharks' win"?
The first one uses "win" as a verb, the second as a noun.
2. What are the possessive forms of "the hysteresis of the piezo" and "the nonlinearities of the images"?
the piezo's hysteresis, the images' nonlinearities
3. If I return to school for five more years I could earn another Ph.D. Then I would have two Ph.D.'s. {American} (or, two PhDs. {British})
4. Referring to the labs of two people: There are many instruments in the two Ph.D.'s {American} laboratories. (or, the two PhDs' laboratories {British})
5. Our lab used to have only one SPM. Now we have two SPMs. The two SPMs' capabilities are very good. But today, the older SPM's laser doesn't work.

Another great Dane has made free
With a question of Be or Not be.
Now might Schroedinger's puss,
In descending by Schuss,
Leave one track on each side of a tree?

-P. Price

18 How to Write a Paper I

I see a lot of students struggling to write their first few scientific publications. They often waste a lot of time and effort by proceeding in an inefficient fashion. I would like to share with you a good method for writing a scientific publication.

STEP I: Determine the content

1. Choose a collection of the figures and tables that represent your work. Sit down with your co-authors and discuss them. Agree on:
 - which figures and tables will be included in the paper,
 - the major points and/or conclusions of your paper, and
 - to which journal you would like to send it. The choice of journal often limits the length and determines the 'flavor' of the paper...for example, is it to be technique oriented, or materials oriented? Should you use English or American spelling.
2. Refine the scientific content of your paper. On two or three pages, outline your publication. That is, write down the ideas that you would like to express, dans n'importe quelle langue, auf Deutsch vielleicht?, and make sure that the ideas are developed in a logical way. Structure the points by Introduction, Theory, Experiment, Results, and Discussion. Structure is very important, because it helps future readers of your work quickly find the information that they need or want.
3. Give your colleagues copies of the outline, along with copies of the figures and tables that you intend to use. Meet with them after they have had time to review the material, and **AGREE ON THE SCIENTIFIC CONTENT OF THE PAPER BEFORE WRITING EVEN ONE SENTENCE OF THE FIRST DRAFT!** This separates problems associated with scientific development from problems associated with English.

STEP II: Preparation of the manuscript

1. One day when you have lots of time, energy and concentration, sit down with your outline and "core dump" your ideas, in any form of English, onto your computer. Do not even stop to look up a word in the dictionary. Do not worry about writing well for the "core dump". It is more important that you have something to work with, and that you get started. You can be confident that the scientific aspects are sound, because you have already discussed them with your colleagues. At this stage, do not worry about the title, author list, abstract, or conclusions.
2. Another day when you feel fresh, return to the manuscript, and try to improve the English. If in the "core dump" you used some words of your native language, find substitutes in English. If you used one word a lot, look up some synonyms in the dictionary. Once you have an acceptable version, then.....
3. Share the first draft with your colleagues. They can help you with the English (They may have more experience.) and check if there is anything missing from the scientific development. Meet with them to discuss their suggestions, and the title, author list, abstract, and conclusions. Your preceptions of your work may have changed during the

course of writing your paper, and now is the time to solidify your ideas about what is important about what you've done. The most significant aspects of your work should be found in the title, abstract, and conclusions. This helps future readers decide if they wish to read your paper.

4. Incorporate your co-author's comments and the title, etc. into the second draft. It is useful at this point to show it to someone outside of your group, who is less familiar with the topic, and who can therefore draw your attention to sections of text that may not be clear.
5. Remember that your publication is your final 'product'. It shall become part of a permanent archive. Take the time to make it something that you can still be proud of next year. Refine the manuscript, give your colleagues one more chance to make improvements, and then.....
6. Submit! Next week I'll say a little about what should go into each section of a publication.

Who needs the balance and check?
Screw peer review –what the heck!
Send all of your crap
To the Internet –zap!
Who cares if it's nothing but dreck!

-D. Morin et al.

19 How to Write a Paper II

There are no firm rules about the exact contents of a scientific publication, but the guiding principle is that you should write so as to aid the reader. Think, therefore, how YOU go about looking at a paper. You read the title, look at the figures, read the abstract and conclusions. Then and only then, if you are still interested, you plunge into the text. As a reader, you would like to see 'the story told' in the title, abstract, figures, tables, and conclusions. The text acts only as supplementary material.

In the course of several semesters of laboratory instruction, I have noticed that students are sometimes not aware of the relative roles of the Abstract, Introduction, Discussion, and Conclusion sections of an article. (Theory, Experiment, and Results are obvious.)

An ABSTRACT, along with the title, is entered into literature databases. This is all the information available from a database search. Hence, the Abstract is a distilled version of your paper. It contains the background, rationale, conclusions, and implications of your work.

The INTRODUCTION places your project within the context of societal needs and interests, and with respect to the work of other groups. Try to answer the questions "Why is this study important?" (background) and "Why did we do it the way that we did?" (rationale) For a longer paper, the Introduction will explain the development of your article.

The DISCUSSION compares theory and experiment, explains possible errors, revisits the work of other groups in light of your new results, and mentions possible avenues for future work, in other words, "What are the implications of what you have done?"

The CONCLUSIONS restate the major results. Write the Conclusions as if a reader has read your paper once, filed it away for a year, then wanted a reminder, in more depth than in the abstract, of what your major results were.

A certain Phys Rev referee
Considers all papers with glee:
"What's new is not true,
And what's true is not new,
Unless it was written by me."

-author unknown

20 Its&It's, Whose&Who's

The two most common mistakes (even by native speakers) concerning the use of the apostrophe are to confuse "its" with "it's"; and "whose" with "who's". These are two examples of using the apostrophe for a contraction- it represents missing letter(s). "It's" means "it is" and "who's" means "who is". In contrast, both "its" and "whose" are possessive pronouns.

1. The computer doesn't work. **Its** disk drive is broken.
2. The weather is nice today. **It's** beautiful.
3. I see a book on the table. **Whose** is it?
4. That student, **who's** very lazy, will never graduate.
5. The researcher, **whose** schedule was very unusual, was at work every night until midnight.
6. Apple Computer is in trouble. **Its** future is in doubt.
7. **Who's** responsible for this equipment?
8. We shouldn't use this equation because **it's** not valid for this temperature range.

A professor of Physics named May
Complains of the classroom today,
"The problem, you know,
Is that they're too slow.
We were far better students than they."

His friend, a professor named Beecham,
Said "It's true, you don't seem to reach 'em.
But they're not to blame,
For they haven't the same
Class of teachers that we had, to teach 'em!"

-B. Elliott

21 Resonant & Resonance

What's wrong with this sentence?

A. The resonance frequency of the system is 10 kHz.

Answer: "resonance" is a noun and should not modify frequency. The sentence should read:

B. The resonant frequency of the system is 10 kHz. OR C. The resonance is at 10 kHz.

"Resonant" is an adjective, and is used properly in sentence B. "Resonant" and "resonance" are frequently confused, usually as in the example A above. Also, "resonate" is a verb; "resonator" is a noun (that which has a "resonance").

Try these:

1. My car has a **resonance** at approximately 1 kHz.
2. Every time that the band plays a bass note, my chest **resonants**.
3. The **resonant** frequency of the buildings that fell in the recent earthquake was about 10 Hz.
4. Organ pipes are good **resonators**.
5. A hollow chamber or cavity chosen to permit internal resonant oscillation of electromagnetic or acoustical waves of specific frequencies is called a **resonator**.
6. An electronic circuit with inductance and capacitance chosen to produce a specified value of the natural frequency of the circuit is called a **resonant** circuit.
7. At the natural frequency, the circuit **resonates**.
8. Above **resonance**, mechanical systems respond inertially.

The chairman of AT&T
Said, "Your graduate physics degree
Is not worth a — penny,
Of your kind we've too many.
Perhaps you can program in C?"

-S. Langer

22 That & Which

What is the difference between:

"The car, which is in the garage, needs a tuneup."

and

"The car that is in the gargage needs a tuneup."?

Answer: The first sentence implies that you own one car, or everyone already knows what car you are talking about. It needs a tuneup. The car happens to be in the garage.

The second sentence implies that you own more than one car. You are specifying what car you are referring to. It is the car that is in the garage which is in poor repair and needs a tuneup.

"Which" clauses are not essential to the understanding of the sentence. "That" clauses are. They clarify what specific object is meant. Notice that the "which" clause is set off by commas, and the "that" clause is not.

1. The sample **that** is in the oven is Sample A.
2. Sample A, **which** is in the oven, is ready for testing.
3. Is "that" properly used in the limerick below?

There are several Great Lies that we know.
One is "I'll love you tomorrow."
Here's another false word
That we've recently heard,
"With less money your research will grow!"

-B. Flower

23 Submit & Subject

To SUBMIT This verb means that an inferior yields to a superior (se soumettre, in French; sich unterwerfen, in German). "I submitted to my boss's request."

SUBMIT is also used for the act when one turns in a paper or other work for evaluation (sousmettre, in French; einreichen [more or less], in German). "I submitted my paper to Science." In both cases, the inferior (me) is complying with the higher authority's (the boss's, or the referee's) desires.

To SUBJECT This is what the superior does to the inferior (soumettre, in French; unterdrucken, in German). "My boss subjected me to a grueling practice seminar." In passive voice: "I was subjected to a grueling practice seminar by my boss." Or, "The sample was subjected to the following treatment:..."

You can see that the mapping between other languages (esp. French) and English is not evident. I believe that this is the reason I often see sentences of the following ilk: "The sample was submitted to a high temperature." This is wrong because the sample has no will, no control over what happens to it. The sample is the inferior. You, the experimenter, subject the sample to its processing.

Practice!

1. I **submitted** my paper yesterday.
2. The proposal was **submitted** yesterday.
3. The crowd **subjected** him to harassment.
4. He was **subjected** to harassment by the crowd.
5. He **submitted** to Saddam's will.
6. I **submitted** to the referee's request.
7. The sample was **subjected** to treatment.

If a packet hits a pocket on a socket on a port,
And the bus is interrupted as a very last resort.
And the address of the memory makes your floppy disk abort,
Then the socket packet pocket has an error to report!

-author unknown

24 Commas

Today I follow closely the book "The Elements of Style", by Strunk and White, Macmillian Company, New York (1972). If you buy only one English grammar/composition book, this is it. It's only 78 pages, but it has all of the important points.

1. Use commas to separate items in a list of three or more.

black and green

red, white, and blue

copper, silver, or gold

Commas should come before the 'and' or 'or'. Otherwise it's not clear if the last two are one item or two. An example is

He lunched on a sandwich, and a glass of milk and coffee.

Now is that a glass of (milk and coffee), or a glass of (milk), and (coffee)? However, in publication lists or company name, where it is clear that the operative unit of interest is individual people, it's acceptable to drop the last comma.

a publication by Burnham, Colton and Pollock

Merrill Lynch, Pierce, Fenner & Smith Incorporated

2. Use TWO commas to 'bracket' parenthetic expressions in the middle of sentences. At the end or beginning of a sentence, use just one comma. A parenthetic expression is one that you could just as well put in paratheses, i.e. it concerns information not essential to the sentence.

The best way to see a country, unless you are pressed for time, is to travel on foot.

Majorie's husband, Colonel Nelson, paid us a visit yesterday.

I think, yes, that it's true.

The lawn mower, which is in the gargage, is broken.

BUT! (Review the lesson of January 23.)

The lawn mower that is in the gargage is broken.

Dates and titles are usually parenthetic. Thus write,

James Wright, Jr.

Well, Susan, this is a fine mess that you are in.

Horace Fulsome, Ph.D., presided February to July, 1972

April 6, 1956

Wednesday, November 13, 1929

But note that 6 April 1958 takes no commas.

3. Use a comma before a conjunction introducing an independent clause.

The early records of the city have disappeared, and the story of its first years can no longer be reconstructed.

The situation is perilous, but there is still one chance of escape.

If the sentence is short, the comma is not required.

Go away and leave me alone!

BUT! Do not use commas to join two independent clauses; semicolons and periods are preferred.

Stevenson's romances are entertaining; they are full of exciting adventures.

Stevenson's romances are entertaining. They are full of exciting adventures.

4. The general rule about punctuation is that it should be used to increase the clarity of your writing.
5. A practical guideline about commas is to read your sentence aloud, and insert commas where you make slight pauses.

Punctuate the following. Optional punctuation is indicated by parentheses.

- The French and American flags are red, white, and blue.
- No, I didn't have time to write the paper.
- You may take the book that is on my desk.
- You may take the book, which is on my desk.
- I don't like the subject; it's boring for me.
- I don't like the subject(,) and I hate doing the homework.
- The paper is written by Smith, Rogers(,) and Jones.
- They refer to the publication by Lu, Chu(,) and Wu.
- I shall be at the meeting from April 10, 1998 to 21 April 1998.
- The year of publication, 1997, was not mentioned.
- Wherever you may be in the future, our wishes go with you, and we are certain of your continued success in your field.

If your cursor finds a menu item followed by a dash,
And the double-clicking icon puts your window in the trash,
And your data is corrupted 'cause the index doesn't hash,
Then your situation's hopeless and your system's gonna crash!

-author unknown

25 Colons and Semicolons

Colons (:) are used to indicate the beginning of a list. Use two spaces after a colon.

This experiment requires the following: a function generator, an oscilloscope, an RC circuit, and an inductor.

You could present the same information in the following way.

This experiment requires a function generator, an oscilloscope, an RC circuit, and an inductor.

In the latter example, no colon was used. In the former, I used a colon as a way of saying "Attention! Here comes the list!" The information after the colon is specific. The phrase before the colon prepares you for the list. The latter example has the same information content as the former. There is more emphasis on what the list items are if a colon is used.

Last week, I said

"Do not use commas to join two independent clauses; semicolons (;) or periods are preferred.

Stevenson's romances are entertaining; they are full of exciting adventures.

Stevenson's romances are entertaining. They are full of exciting adventures."

There is one other situation in which to use semicolons. If you have a long list where each item is composed of several different things, then separate the items with semicolons.

On my vacation I shall take: two pairs of skis and boots, each optimized for different snow conditions; warm clothing for cold weather and lighter clothing for sunny days, along with my favorite mult-purpose hat; and good reading material, including my favorite book, which I've already read three times.

Scientists frequently use colons and semicolons in figure captions.

Figure 1. The major results of our study: a) TEM image of bacteria; b) AFM image of bacteria; c) cross-sectional profile of the bacteria; and d) corresponding response as a function of load.

Punctuate the following using commas, semicolons, or colons. Optional punctuation is indicated by parentheses.

1. Eat, and drink this tea.
2. Listen, and write an essay.
3. Do the experiment(,) and write a paper.
4. Do the experiment; write a paper.
5. We used the following approach: we first laid the DNA on the substrate and let it dry; then we used an AFM to image the DNA and determine its conformation; the image was then used to generate data; and(,) finally(,) the Flory exponent was determined.
6. I need three items: methanol, acetone, and distilled water.

If the label on the cable on the table at your house
Says the network is connected to the button on the mouse,
But your packets want to tunnel on another protocol,
That's repeatedly rejected by the printer down the hall,
And your screen is all distorted by the side affects of Gauss,
So your icons in the windows are so wavy as a souse,

Then you may as well reboot and go out with a bang,
'Cause as sure as I'm a poet, the sucker's gonna hang!

-author unknown

26 Dashes

Two weeks ago I described how commas are used to bracket parenthetical phrases. Dashes can be used in the same way. Dashes add more interest and emphasis to the parenthetical phrase.

Many of them—about half—will remain at home.

I longed—so very much—for a drink of lemonade!

The dashes above could easily be replaced by commas. The following examples are better with dashes than with commas—

He sometimes cooked for his friends a simple dinner—a veal pie and rice pudding.

Five nations—namely, England, France, Germany, Italy, and Russia—were represented in that one army. (If the list of nations was at the end of this sentence, a colon would be a better choice.)

If the dashes were replaced by commas in these two latter sentences, there could be some confusion between the parenthetical and major parts of the sentence.

Use whatever punctuation you think appropriate.

1. Amonton formulated his law relating friction and the normal load 300 years ago; a hundred years later, Coulomb interpreted friction in terms of cobblestones in a rough road—the bigger the stones, the higher the friction.
2. In other words, the friction is not only anisotropic—dependent on the angle of the tip's motion with respect to the domain orientation—but is also asymmetric, that is, different for the trace and retrace of the force microscope tip over the same scan line.
3. We used Brewster angle microscopy to obtain essential information about the tilt angle of the alkyl chains and their tilt direction (azimuthal angle); this technique is based on p-polarized light and allows local determination of these parameters.
4. Our interpretation of the results—the alkyl chains are hexagonally packed and slightly tilted with a uniform tilt direction within each petal.

Without punctuation, these sentences are hard to understand!

-author unknown

27 Collective Nouns

Collective nouns denote a collection of persons or things regarded as one unit. An example is a sports team—many individuals, one team. Collective nouns are difficult to use correctly because they sometimes are singular nouns, and sometimes are plural ones. And you must match the verb to the right case.

In "The orchestra was playing.", the orchestra was performing as one unit. In "The orchestra have all gone home.", the plural verb form is used because the individual members of the orchestra acted separately. "Inter-Milan beats Ajax." is in the former sense; "Inter-Milan have assaulted Ajax." is in the latter. (As long as it is individuals who have been violent, not the team as a group.)

The distinction between what is a collective noun and what isn't is often harder to establish than in the examples above. "The variety of techniques in our lab is wonderful." refers to the broad spectrum of possibilities in our lab and is singular. However, I would choose to say "A variety of techniques were employed to study the material." because the emphasis is on the multiplicity of possibilities. Grammarians might disagree with me, but I invoke the native speaker's "sounds right" rule. :-)

Try these. Use the verb in parentheses.

1. (have) EPFL **has** not won the game.
2. (work) The students **work** very hard.
3. (work) That group **works** very hard.
4. (work) That group of students **works** very hard.
5. (work) These groups of students **work** very hard.
6. (have) That group **has** finished their lab and **have** gone home.
7. (be) Work schedules, delivery times, costs—this information **is** very useful to me.
8. (be) Work schedules, delivery times, costs—these bits of information **are** very useful to me.

N.B. In English, "these informations" don't (or doesn't?) exist.

..the mass starts into a million suns;
Earths round each sun with quick explosions burst,
And second planets issue from the first.

-Eramus Darwin (1731-1802)

28 A and An

The easy rule, right 80% of the time, is that "a" is the indefinite article used before a noun starting with a consonant, and "an" is the indefinite article for use before a noun starting with a vowel.

But to be 100% correct is more challenging. The reason for invoking "an" is to avoid the awkward tongue twisting associated with saying "a eel". It's much easier to say "an eel." Here English shares something with French, in that the correct grammatical form depends on what sounds right or is easy to say. So the correct, more challenging rule is that "an" appears before nouns that start with vowel *sounds*, in contrast to written vowels. My favorite examples from my field: "a scanning probe microscope", but "an SPM" (pronounced ES-PEE-EM); "an ultra-high vacuum chamber", but "a UHV chamber" (pronounced YEW-AICH-VEE).

Place "a" or "an" in the blanks.

1. Please send me **an** email.
2. The system is **a** eutectic (YEW-TEC-TIC) at 300K.
3. The temperature was increased by **an** electron beam heater.
4. We used **a** lateral force microscope (LFM).
5. We used **an** LFM. (EL-EF-EM)
6. **An** 8 (EIGHT) ML overlayer of Pd was deposited on the sample.
7. **A** uniform (YEW-NI-FORM) layer was achieved.
8. **An** oxygen dosing was the next step in the preparation.
9. The system can be modeled by **a** harmonic oscillator.
10. The system can be modeled by **an** anharmonic oscillator.
11. **An** Auger electron spectrometer (AES) was employed....
12. **An** AES was employed....
13. **An** X-ray (EX-RAY) photoelectron spectrometer (XPS) revealed...
14. **An** XPS (EX-PEE-ES) revealed...
15. Use of **a** scanning electron microscope (SEM) showed...
16. Use of **an** SEM showed....
17. We used **a** fourier-transform infrared spectrometer (FTIR) to determine...
18. We used **an** FTIR (EF-TEE-EYE-ARE) to determine...
19. **An** ultra-violet photoelectron spectrometer (UPS) displayed....
20. **A** UPS (YEW-PEE-ES) displayed...

Knows't thou how blood, which to the heart doth flow,
Doth from one ventricle to the other go?

-John Donne, 1612 (At the time, no one knew.)

29 Actual and Eventual

The words in German and French that sound closest to actual are "aktuell" and "actuel", respectively. They mean contemporary or up-to-date. Paired with "actual" they are "faux amis", in that "actual" usually means "in fact". I say usually, because a less common definition of actual does correspond to contemporary. I suggest that it's best to forget the second definition, for it is so often ill-applied.

Eventual is used for what in the future may actually become true. Here are the definitions from the Random House Unabridged CD-ROM Dictionary.

ACTUAL

1. existing in act or fact; real: *an actual case of heroism; actual expenses.*

Syn.1. genuine, authentic, veritable, real.

EVENTUAL

1. happening at some indefinite future time or after a series of occurrences; ultimate: *His mistakes led to his eventual dismissal.*

2. depending upon uncertain events; contingent.

Syn.1. subsequent, consequent, later, resulting.

Replace the blanks with actual, actually, eventual, or eventually.

1. **Eventually**, the instrument will run correctly.
2. **Actually**, it does not run. (This sentence is a case where both the common and less common meanings of actual, i.e. real and contemporary, both work.)
3. The **eventual** data will be very interesting.
4. Although our simulations predict what the data will reveal, we have no **actual** data.

There rolls the deep where grew the tree
O earth, what changes hast thou seen!
There where the long street roars, hath been
The stillness of the central sea.

The hills are shadows, and they flow
>From form to form, and nothings stands;
They melt like mist, the solid lands,
Like clouds they shape themselves and go.
-Tennyson, on geological change

30 The Wondrous and Terrible Verb "to Get"

Wondrous because it is so flexible...it has 63 different definitions! Terrible because.....it has 63 different definitions! The particular meaning is determined largely by context.

Please don't use it in your writing. It is a very informal word, appropriate for conversation and seminars but not for publications. Much better synonyms exist.

I shall provide the full set of definitions on this week's Scientific English web page. Here are a few synonyms just to *get* you started (from the Random House Dictionary):

GET, OBTAIN, ACQUIRE, PROCURE, SECURE imply gaining possession of something. GET may apply to coming into possession in any manner, and either voluntarily or not. OBTAIN suggests putting forth effort to gain possession, and ACQUIRE stresses the possessing after an (often prolonged) effort. PROCURE suggests the method of obtaining, as that of search or choice. SECURE, considered in bad taste as a would-be-elegant substitute for GET, is, however, when used with discrimination, a perfectly proper word. It suggests making possession sure and safe, after obtaining something by competition or the like.

Can you provide synonyms for "get" for the following sentences? (I think these are the most frequently used meanings.)

1. I forgot my pen. I'll go **fetch** one.
2. This problem is really hard. I don't **understand** it.
3. I **received** your letter.
4. I'm sorry I wasn't here yesterday. I **caught** a cold.
5. Last time I went skiing, I **became** really cold.

Got it?

For your reference purposes, here are the definitions from the Random House Unabridged CD-ROM Dictionary:

get v., got or (Archaic) gat; got or got•ten; get•ting, n.

Transitive verb

1. to receive or come to have possession, use, or enjoyment of: to get a birthday present; to get a pension.
2. to cause to be in one's possession or succeed in having available for one's use or enjoyment; obtain; acquire: to get a good price after bargaining; to get oil by drilling; to get information.
3. to go after, take hold of, and bring (something) for one's own or for another's purposes; fetch: Would y get the milk from the refrigerator for me?.
4. to cause or cause to become, to do, to move, etc., as specified; effect: to get one's hair cut; to get a person drunk; to get a fire to burn; to get a dog out of a room.

5. to communicate or establish communication with over a distance; reach: You can always get me by telephone.
6. to hear or hear clearly: I didn't get your last name.
7. to acquire a mental grasp or command of; learn: to get a lesson.
8. to capture; seize: Get him before he escapes!
9. to receive as a punishment or sentence: to get a spanking; to get 20 years in jail.
10. to prevail on; influence or persuade: We'll get him to go with us.
11. to prepare; make ready: to get dinner.
12. (esp. of animals) to beget.
13. Informal. to affect emotionally: Her pleas got me.
14. to hit, strike, or wound: The bullet got him in the leg.
15. Informal. to kill.
16. Informal. to take vengeance on: I'll get y yet!
17. to catch or be afflicted with; come down with or suffer from: He got malaria while living in the tropics. She gets butterflies before every performance.
18. Informal. to puzzle; irritate; annoy: Their silly remarks get me.
19. Informal. to understand; comprehend: I don't get the joke. This report may be crystal-clear to a scientist, but I don't get it.

Intransitive verb

1. to come to a specified place; arrive; reach: to get home late.
2. to succeed, become enabled, or be permitted: You get to meet a lot of interesting people.
3. to become or to cause oneself to become as specified; reach a certain condition: to get angry; to get sick.
4. (used as an auxiliary verb fol. by a past participle to form the passive) : to get married; to get elected; to get hit by a car.
5. to succeed in coming, going, arriving at, visiting, etc. (usually fol. by away, in, into, out, etc.) : I don't get into town very often.
6. to bear, endure, or survive (usually fol. by through or over) : Can he get through another bad winter?.
7. to earn money; gain.
8. Informal. to leave promptly; scam: He told us to get.

9. to start or enter upon the action of (fol. by a present participle expressing action) : to get moving; Get rolling. 29. get about,a. to move about; be active: He gets about with difficulty since his illness. b. to become known; spread: It was supposed to be a secret, but somehow it got about. c. to be socially active: She's been getting about much more since her family moved to the city. Also, get around.
10. get across,a. to make or become understandable; communicate: to get a lesson across to students. b. to be convincing about; impress upon others: The fire chief got across forcefully the fact that turning in a false alarm is a serious offense.
11. get ahead, to be successful, as in business or society: She got ahead by sheer determination.
12. get ahead of,a. to move forward of, as in traveling: The taxi got ahead of her after the light changed. b. to surpass; outdo: He refused to let anyone get ahead of him in business.
13. get along,a. to go away; leave. b. See get on.
14. get around,a. to circumvent; outwit. b. to ingratiate oneself with (someone) through flattery or cajolery. c. to travel from place to place; circulate: I don't get around much anymore. d. See get about.
15. get at,a. to reach; touch: to stretch in order to get at a top shelf. b. to suggest, hint at, or imply; intimate: What are y getting at?. c. to discover; determine: to get at the root of a problem. d. Informal. to influence by surreptitious or illegal means; bribe: The gangsters couldn't get at the mayor.
16. get away,a. to escape; flee: He tried to get away, but the crowd was too dense. b. to start out; leave: The racehorses got away from the starting gate.
17. get away with, to perpetrate or accomplish without detection or punishment: Some people lie and cheat and always seem to get away with it.
18. get back,a. to come back; return: When will y get back?. b. to recover; regain: He got back his investment with interest. c. to be revenged: She waited for a chance to get back at her accuser.
19. get by, a. to succeed in going past: to get by a police barricade. b. to manage to exist, survive, continue in business, etc., in spite of difficulties. c. to evade the notice of: He doesn't let much get by him.
20. get down,a. to bring or come down; descend: The kitten climbed the tree, but then couldn't get down again. b. to concentrate; attend: to get down to the matter at hand. c. to depress; discourage; fatigue: Nothing gets me down so much as a rainy day. d. to swallow: The pill was so large that he couldn't get it down. e. to relax and enjoy oneself completely; be uninhibited in one's enjoyment: getting down with a bunch of old friends.
21. get even. See even 1 (def. 22).
22. get going,a. to begin; act: They wanted to get going on the construction of the house. b. to increase one's speed; make haste: If we don't get going, we'll never arrive in time.

23. get in, a. to go into a place; enter: He forgot his key and couldn't get in. b. to arrive; come: They both got in on the same train. c. to become associated with: He got in with a bad crowd. d. to be chosen or accepted, as for office, membership, etc.: As secretary of the club, his friend made sure that he got in. e. to become implicated in: By embezzling money to pay his gambling debts quickly, he was getting in further and further.
24. get it, Informal. a. to be punished or reprimanded: You'll get it for breaking that vase!. b. to understand or grasp something: This is just between us, get it?.
25. get it off, Slang (vulgar). to experience orgasm.
26. get it on, a. Informal. to work or perform with satisfying harmony or energy or develop a strong rapport, as in music: a rock group really getting it on with the audience. b. Slang (vulgar). to have sexual intercourse.
27. get it up, Slang (vulgar) , to achieve an erection of the penis.
28. get off, a. to escape the consequences of or punishment for one's actions. b. to help (someone) escape punishment: A good lawyer might get y off. c. to begin a journey; leave: He got off on the noon flight. d. to leave (a train, plane, etc.) ; dismount from (a horse) ; alight. e. to tell (a joke) ; express (an opinion) : The comedian got off a couple of good ones. f. Informal. to have the effrontery: Where does he get off telling me how to behave?. g. Slang (vulgar). to experience orgasm. h. to experience or cause to experience a high from or as if from a drug. i. to cause to feel pleasure, enthusiasm, or excitement: a new rock group that gets everyone off.
29. get off on, Slang. to become enthusiastic about or excited by: After years of indifference, she's getting off on baseball.
30. get on or along, a. to make progress; proceed; advance. b. to have sufficient means to manage, survive, or fare. c. to be on good terms; agree: She simply can't get on with her brothers. d. to advance in age: He is getting on in years.
31. get out, a. to leave (often fol. by of) : Get out of here! We had to get out of the bus at San Antonio. b. to become publicly known: We mustn't let this story get out. c. to withdraw or retire (often fol. by of) : He decided to get out of the dry goods business. d. to produce or complete: Let's get this work out!.
32. get over, a. to recover from: to get over an illness. b. See get across.
33. get round. See get around.
34. get the lead out. See lead 2 (def. 11).
35. get there, to reach one's goal; succeed: He wanted to be a millionaire but he died before he got there.
36. get through, a. to succeed, as in meeting, reaching, or contacting by telephone (usually fol. by to) : I tried to call y last night, but I couldn't get through. b. to complete; finish: How he ever got through college is a mystery. c. to make oneself understood: One simply cannot get through to her.

37. get to, a. to get in touch or into communication with; contact: It was too late by the time he got to the authorities. b. Informal. to make an impression on; affect: This music really gets to y. c. to begin: When he gets to telling stories about the war, there's no stopping him.
38. get together, a. to accumulate; gather: to get together a portfolio of 20 stocks. b. to congregate; meet: The alumnae chapter gets together twice a year. c. to come to an accord; agree: They simply couldn't get together on matters of policy.
39. get up, a. to sit up or stand; arise. b. to rise from bed. c. to ascend or mount. d. to prepare; arrange; organize: to get up an exhibit. e. to draw upon; marshal; rouse: to get up one's courage. f. to acquire a knowledge of. g. (to a horse) go! go ahead! go faster!. h. to dress, as in a costume or disguise: She got herself up as an astronaut. i. to produce in a specified style, as a book: It was got up in brown leather with gold endpapers.
40. has or have got, a. to possess or own; have: She's got a new car. Have y got the tickets?. b. must (fol. by an infinitive) : He's got to get to a doctor right away. c. to suffer from: Have y got a cold?

Noun

1. an offspring or the total of the offspring, esp. of a male animal: the get of a stallion.
2. a return of a ball, as in tennis, that would normally have resulted in a point for the opponent.
3. Brit. Slang a. something earned, as salary, profits, etc.: What's your week's get?. b. a child born out of wedlock. [1150–1200; (v.) ME *geten* < ON *geta* to obtain, beget; c. OE *-gietan* (>ME *yeten*) , G *-gessen*, in *vergessen* to forget; (n.) ME: something gotten, offspring, deriv. of the v]

get, ta•ble, get, a•ble, adj.

Synonyms GET, OBTAIN, ACQUIRE, PROCURE, SECURE imply gaining possession of something. GET may apply to coming into possession in any manner, and either voluntarily or not. OBTAIN suggests putting forth effort to gain possession, and ACQUIRE stresses the possessing after an (often prolonged) effort. PROCURE suggests the method of obtaining, as that of search or choice. SECURE, considered in bad taste as a would-be-elegant substitute for GET, is, however, when used with discrimination, a perfectly proper word. It suggests making possession sure and safe, after obtaining something by competition or the like. 2. win, gain. 7. apprehend, grasp. 10. induce, dispose. 12. engender.

Usage For nearly 400 years, forms of GET have been used with a following past participle to form the passive voice: She got engaged when she was 19. He won't get accepted with those grades. This use of GET rather than of forms of to be in the passive is found today chiefly in speech and informal writing. In British English GOT is the regular past participle of GET, and GOTTEN survives only in a few set phrases, such as ill-gotten gains. In American English GOTTEN, although occasionally criticized, is an alternative standard past participle in most senses, especially in the senses "to receive" or "to acquire": I have gotten (or got) all

that I ever hoped for.HAVE or HAS GOT in the sense "must" has been in use since the early 19th century; often the HAVE or HAS is contracted: You've got to carry your passport at all times. The use of HAVE (or HAS) GOT in the sense of "to possess" goes back to the 15th century; it is also frequently contracted: She's got a master's degree in biology. These uses are occasionally criticized as redundant on the grounds that HAVE alone expresses the meaning adequately, but they are well established and fully standard in all varieties of speech and writing. In some contexts in American English, substituting GOTTEN for GOT produces a change in meaning: She's got (possesses) a new job. She's gotten (has aquired) a new job. He's got to (must) attend the wedding. He's gotten to (has been allowed or enabled to) attend. The children have got (are suffering from) the measles. The children have gotten (have caught) the measles. The use of GOT without HAVE or HAS to mean "must" (I got to buy a new suit) is characteristic of the most relaxed, informal speech and does not occur in edited writing except in representations of speech. GOTTA is a pronunciation spelling representing this use.

Pronunciation The pronunciation (git) for GET has existed since the 16th century. The same change is exhibited in (kin) for CAN and (yit) for YET. The pronunciation (git) is not regional and occurs in all parts of the country. It is most common as an unstressed syllable: Let's get going! (lets, git gé,ing). In educated speech the pronunciation (git) in stressed syllables is rare.

Entropy!
Thou seal on extinction,
Thou curse on Creation.
All change distributes energy,
Spills what cannot be gathered again.
The night sky blazes with Byzantine waste.

-from 'Ode to Entropy' by John Updike

31 Possessives

The possessive, or genitive, is usually formed in English by adding " 's " to the end of a noun, e.g. John's house. If a singular noun ends in " s ", then also add " 's", as in "a praying mantis's head". If the plural noun already ends in "s", then just add an apostrophe, e.g. the mantis' heads or the Smiths' house. If it is a compound noun, e.g. Dan and Sally, then we say "Dan and Sally's house", not "Dan's and Sally's house." If there are successive levels of possession, it looks like this—"Dan and Sally's house's plumbing." But the multiple " 's " would *look funny* in a publication.

We tend not to write "the motor's inductance." Usually we write "the inductance of the motor." The difference is whether the noun is a person or a thing. Therefore, the more common usage is to write "my sister's cat", and "the oscillation of the swing", instead of "the cat of my sister", and "the swing's oscillations." These latter are not wrong, they just *sound funny* to a native speaker. Animals are generally treated as people, e.g. "the cat's leg", or "my sister's cat's leg". See quotation below.

Thank goodness there's a little flexibility. If the rule was that you always had to use "of" with things, then one would have phrases such as "the brim of the hat of the captain of the steamboat of the Donau River." My natural tendency would be to say "the brim of the Donau River steamboat captain's hat." The latter is much shorter and less awkward than the former. I used "Donau River steamboat captain" as a collective noun. (By the way, German is great for collective nouns—one can say "Donau-Dampfschiffahrts-Kapitaens-Muetzen-Schild" for the entire phrase.)

What would you do to the following phrases to make them more readable? Or would you leave them as they are?

1. the damping of the tip of the cantilever of the atomic force microscope
the damping of the atomic force microscope cantilever's tip
2. the noise in Liz's pendulum **OK**
3. the resistance of the probe **OK**
4. the resume of the scientist
the scientist's resume
5. the brain cells of the mouse
OK, or the mouse's brain cells
6. the amplitude of the pattern of interference of two actuators of ultrasound
the amplitude of the interference pattern of two ultrasonic actuators

"The removal of the male praying mantis's head actually improved its sexual performance.

This was because the subesophageal ganglion (near the head) normally inhibits the copulatory movement of the abdomen. Once the subesophageal ganglion has been removed, by decapitating the insect, it will copulate with almost anything."

-K.D. Roeder, Biological Bulletin, October 1935

32 Among and Between

With respect to a relationship among two or more objects, use "among". With respect to a relationship between two objects, use "between". Unfortunately, life is not so simple, and there is a complication in that "between" is also used for any number of individual people or things. Some examples are: 1) Among my friends, Fred is the best cook; 2) Between you and me, I have more culinary experience; 3) The responsibility for this evening's meal is shared between Fred, Mike, and David.

Which poster titles are correct?

1. Microscopy–A Comparison between Two Techniques **RIGHT**
2. Microscopy–A Comparison among Two Techniques **WRONG**
3. Microscopy–A Comparison between Three Techniques **WRONG**
4. Microscopy–A Comparison among Three Techniques **RIGHT**
5. Microscopy–A Comparison among Electron, Optical, and Scanning Probe Approaches **WRONG**
6. Microscopy–A Comparison between Electron, Optical, and Scanning Probe Approaches **RIGHT**

Science is the Differential Calculus of the mind.

Art is the Integral Calculus
they may be beautiful when they are apart
but they are greatest only when combined

-Sir Ronald Ross

33 Logical and Chronological Adverbs

As scientists, we often describe a process or experiment, and we would like to express ourselves in a logical way. To emphasize the logical or chronological result of a certain pattern of thinking, we use words or phrases such as:

therefore,
wherefore,
hence,
thus,
ergo,
as a result,
resultingly,
accordingly,
consequently,
so, and
then.

The first nine are used almost synonymously in formal writing; the first seven of which imply very exact reasoning. The last two are informal and should not appear in a scientific paper. But of course there are exceptions—"then" is properly employed in a chronological sequence, e.g., first I got out of bed, then I took a shower, then I had breakfast, and then I went to work. Also, you can use "so" in a publication in the word groupings "so as to" or "so that" to introduce a logical result, for example, "Turn up the voltage so as to obtain a stronger signal", or alternatively, "Turn up the voltage so that a stronger signal is obtained."

The Random House CD-ROM Dictionary clarifies the subtle differences between some of the synonyms listed above. —

Syn. hence, whence. **THEREFORE**, **WHEREFORE**, **ACCORDINGLY**, **CONSEQUENTLY**, **SO**, **THEN** all introduce a statement resulting from, or caused by, what immediately precedes. **THEREFORE** (for this or that reason) and **WHEREFORE** (for which reason) imply exactness of reasoning; they are esp. used in logic, law, mathematics, etc., and in a formal style of speaking or writing. **ACCORDINGLY** (in conformity with the preceding) and **CONSEQUENTLY** (as a result, or sequence, or effect of the preceding) , although also somewhat formal, occur mainly in less technical contexts. **SO** (because the preceding is true or this being the case) and **THEN** (since the preceding is true) are informal or conversational in tone.

Place one of the words discussed above in the blanks. It could be that more than one word is correct.

1. A plus B equals C. _____ it follows that C minus B equals A.

Therefore, Wherefore, Hence, Thus, Ergo, As a result, Resultingly

2. First the sample was placed into the chamber, **then** the monolayer was deposited.

3. The administration has imposed new rules and regulations. We must rewrite our safety manuals _____.

accordingly, consequently

4. "Your talk was super! _____ you must have practiced it a lot!" **So, Then**

5. The pH of the solution was changed **so that** the DNA unfolded.

There was a young lady named Bright,
Who travelled much faster than light.
She started one day
In the relative way
And returned on the previous night.

-Arthur Buller, ~1920

34 The Interview Talk

Many of you are Ph.D. students, and will soon be looking for a job. Often you must present your work to your prospective employer during an interview. Here are some guidelines for your interview talk. They were first formulated by Dr. Gordon Pike, of Sandia National Labs, USA, and then adapted by me.

Audience Who is your audience? Primarily Ph.D. scientists? Graduate students? Undergraduates? You can't make your talk interesting and accessible to everyone, but you can ensure that each person understands at least part of it. For teaching positions, it is especially important to demonstrate that you can explain your work clearly.

Objectives The audience will be considering these questions:

1. Is the research problem well posed? How does it relate to previous work in the area? Is it do-able? Will anyone care about the results?
2. Was the attack on the problem systematic? Were all appropriate theoretical, experimental and analytical tools used? Is skill at analysis of a problem evident?
3. Were the critical experiments (the ones that really prove a hypothesis) identified and done?
4. Is the interpretation of the results perceptive? Is there skill at synthesis of a solution?
5. Are the conclusions reasonable? Are the strengths and weaknesses of the data correctly reflected in the conclusions?

General Impressions In addition to answering these questions, you should be aware that the general impression you leave is important. You want to be seen as a systematic thinker who is relaxed and interested in his/her topic. You want to demonstrate both breadth and depth. By breadth we mean that you should demonstrate that you know how your piece of work fits into the larger technical context and what impact the work will have. By depth we mean that you should show that you know more about the narrow area of your thesis work than anyone in the audience. Of course, this needs to be done delicately, without arrogance. Pick some facet of your work and spend about 10 minutes or so focusing on it in depth.

Questions There will be time at the end of the talk for a few questions and you need to respond directly and honestly to all of them. In many interviews you will be spending more time with the individuals in the audience so you will have the opportunity to discuss questions at length.

Perspective Keep in mind that your presentation just sets the tone and gives general impressions. You often are given time for private discussions to learn more about your prospective colleagues and for them to learn about you.

Neutrinos, they are very small,
They have no charge and have no mass
And do not interact at all.
The earth is just a silly ball
To them, through which they simply pass,
Like dustmaids down a drafty hall
Or photons though a sheet of glass.
They snub the most exquisite gas,
Ignore the most substantial wall
Cold-shoulder steel and sounding brass,
Insult the stallion in his stall
And, scorning barriers of class,
Infiltrate you and me! Like tall
And painless guillotines, they fall
Down through our heads into the grass.
At night, they enter at Nepal
And pierce the lover and his lass
>From underneath the bed - you call
It wonderful; I call it crass.

-M.A. Ruderman and A.H. Rosenfeld

35 Editing Equations

A common mistake is to treat equations differently from text. You should think of your equations as sentences. Isn't "A equals B" the same as "A = B"? Therefore you should punctuate an equation as you would a sentence. The following equation is a complete thought.

$$A + B = C$$

A sentence needs a period. If you want to specify what A, B, and C are, then you would punctuate differently.

$$A + B = C,$$

where A is the number of adult gnus, B is their offspring, and C is the total population of the herd. Notice that I did not indent the word "where", because it is not the beginning of a new paragraph. If I change subjects, as I shall now do, I would make the subsequent sentence a new paragraph, and consequently indent. Given that A is the number of adult gnus, B is their offspring, and C is the total population of the herd, we arrive at

$$A + B = C.$$

Isn't it easy, once you think about it? There's no reason that an equation can't end with an exclamation point or a question mark. If you are astonished that gnu populations are growing so rapidly, you would write

$$A + B = C !!$$

(Notice that I put space between "C" and the first exclamation point, and used two, not one, exclamation points, in order to avoid confusion with the symbol "!" for factorials.) And if you were learning math, you might ask if

$$A + B = C ?$$

In the beginning was a black bomb
That blew apart. A blinding smoke
Kept growing, growing

To a tropical fog, intolerably bright.
>From this, white whorls of moonshine mist
Distilled, and then distilled
To petal-eddies on a dark pool.
And now they spin in clusters
Farther and farther apart
Like shining catkins, twisted into spools.
All forms, all time, all complexity,
>From the first snowdrop to muffins and tea
Lay in that round black bomb
And will return there
When the hot afternoon is done.
-E. Larrissy

36 Writing Mathematics

Let's continue this week with more tips about writing mathematics. Boldface type indicates the preferred style.

- Please don't begin a sentence with a variable. Doesn't "a is greater than b." look odd to you? When I read it, I am confused because I think that "a" is the article "a", not a variable. I would choose to write "The variable *a* is greater than b." It helps to italicize the variables.
- Words should be interspersed with formulas to give a smoother flow. I much prefer "If $x < 2$, then $y > 5$." to "If $x < 2$, $y > 5$."
- Complicated or important formulae should stand out from the text. Trying to read $P = \frac{Ka^3}{R} - \sqrt{PiwKa^{3/2}} - PiRw$ in the middle of a paragraph is much more difficult than reading it below

$$P = \frac{Ka^3}{R} - \sqrt{PiwKa^{3/2}} - PiRw \quad (1)$$

- When referring back to an earlier equation, it's useful to include an additional clue to the reader as to which equation you mean, in addition to the equation number. For example, I want to talk now about Eq.1. You're lucky, Eq.1 is just above this paragraph. But had I referred to Eq.1. several pages later, it would be of immense value to the reader to write "The expression for P, Eq.1, is used to plot Fig.X."
- If in doubt, be consistent. There's no Academy of English to dictate exactly what is right and wrong. We therefore have enormous flexibility as writers, but also uncertainty. A publication looks sloppy if in one place you type "x-axis" and then later "x axis". It's better to be consistent than right.

The wireless telegraph is not difficult to understand.

The ordinary telegraph is like a long cat.

You pull the tail in New York, and it meows in Los Angeles.

The wireless is the same, only without the cat.

-A. Einstein

37 Look it up!

Non-native speakers of English have an advantage over native speakers. Non-native speakers are not ashamed to consult dictionaries if they are in doubt about the meaning of a word. Native speakers are lazy. If confronted with a word they don't know, they infer its meaning from the context, then later use the word according to their own private definition. Warning lights should blink! Alarms should ring! Let me give you an example of what happens.

Spiro Agnew, Richard Nixon's vice president, criticized opponents of the Vietnam War with the phrase "effete corps of impudent snobs." The word pair "effete snobs" is now part of American every-day vocabulary. What does it mean to you?

For at least the last 300 years, "effete" has meant "worn out, unable to produce." But after this (in)famous pronouncement by Agnew, everyone who didn't know its intended meaning gave it their own. Imagine the confusions associated with the following two interviews.

- On a radio talk show, the host asked his guest, the author of a biography about Margaret Mitchell, whether Mitchell's finance was effete. The answer was "[He had] many effeminate qualities."
- On another radio talk show, the host asked the guest, the editor of The New York Review of Books, whether he thought his publication was effete. The answer was that the Review was elite, but not snobbish or exclusive.

There you are, two new definitions of effete! To some, it now means *effeminate* or *elite*, definitions very different from its original meaning of worn out.

I hope I have inspired you to keep a dictionary at your side when writing. Colloquially expressed, if you are not sure of the meaning of a word, **look it up!**

(This lesson was inspired by a newspaper article written by C.H. Elster.)

Course Description P287 - Feminist Cosmology

The Big Bang Model is exposed a purely male paradigm, deliberately replete with male sexual symbolism in order to deny empowerment to women. A more progressive feminine cosmology, the Gentle Nurturing, is offered to replaced the male Big Bang theory. The Gentle Nurturing model views the origin of the universe as lengthy period of gradual gestation, followed by steady nurturing, rather than a sudden eruption. The male originators of the Big Bang theory are examined critically for their role in maintaining an oppressive order through the manipulation of physics. The new paradigm shows that we are part of an interconnected cosmic entity which must be further nurtured and protected from the harms inflicted by the radical right.

-from "Politically Correct Physics" by Jeff Lindsay

38 Verb Groups

In my drafts of scientific publications, I often find myself repeating the same verbs. When editing my first attempts, I try and create as much variety as possible by using a large selection of verbs. This is hard for you, the non-native speaker, because your vocabulary is understandably less well developed. Here are lists of verb groups that may help you extend your vocabulary. The words within the same group are not necessarily synonyms, but are related. I shall quiz you on their meanings and usage some other time!

Verb Group	Synonyms
Acquisition	acquire, obtain, retrieve, compile, accumulate, assemble, amass
Causation	yield, give, result, return, derive, follow, cause, effect, originate, contribute, produce, create, kindle, determine
Communication	communicate, reason, comprehend, understand, estimate, evaluate, realize, demonstrate, appreciate, judge, grasp, debate, inquire, argue, contend, induce, deduce
Description	describe, discuss, comment, account, state, report, specify, summarize, delineate, portray, characterize, detail, recount, recite, itemize, show, display, summarize, elaborate
Observation	observe, see, note, notice, discern, distinguish, discriminate, differentiate, perceive, recognize
Representation	represent, illustrate, show, indicate, mark, label, denote, symbolize, exhibit, sketch, graph, plot, display, present, model, design, chart, image, photograph, diagram
Utilization	utilize, use, employ, serve, function, apply, work, avail, help, aid

Two nuns went out of their convent to sell cookies. One of them is known as Sister Mathematical (S.M.), the other is known as Sister Logical (S.L.). It is getting dark and they are still far away from the convent.

S.L.: Have you noticed a man that has been following us for the past half hour?

S.M.: Yes, I wonder what he wants?

S.L.: It's logical. It's logical. He wants to rape us.

S.M.: Oh no! At this pace he will reach us in 15 minutes at the most. What can we do?

S.L.: The only logical thing to do of course, we have to start walking faster.

S.M.: It's not working.

S.L.: Of course it's not working, the man did the only logical thing to do. He also started to walk faster.

S.M.: So, what shall we do? At this pace he will reach us in less than 1 minute.

S.L.: The only logical thing we can do is split up. He cannot follow both of us.

So the man decided to go after Sister Logical. Sister Mathematical arrives at the convent and is worried because Sister Logical has not arrived yet. Finally, Sister Logical arrives.

S.M.: Sister Logical! Thank God you are here. Tell us what happened?

S.L.: The only logical thing happened. The man could not follow both of us, so he decided to go after me.

S.M.: So, what happened? Please tell us.

S.L.: The only logical thing to happen, I started to run as fast as I could.

S.M.: So what happened?

S.L.: The only logical thing to happen, the man also started to run as fast as he could.

S.M.: And what else?

S.L.: The only logical thing to happen, he reached me.

S.M.: Oh, no. what did you do then?

S.L.: The only logical thing to do...I took my dress up.

S.M.: Oh Sister, what did the man do?

S.L.: The only logical thing to do, he pulled down his pants.

S.M.: Oh, NO! What happened then?

S.L.: Isn't it logical Sister? A nun with her dress up runs faster than a man with his pants down!

-Author unknown

39 Premodification of Nouns by Nouns

Nouns can be modified by subordinate clauses, as in "We visited their house, which is charming." Alternatively, one can write "We visited their charming house.", in which case the modifier is before the noun, i.e. "charming" is a premodifier.

Premodification can be accomplished by many means:

Adjective. We visited their delightful house.

Participles. We visited their charming house. We visited their decayed house.

S genitive. We visited their fisherman's house.

Noun. We visited their country house.

Adverbial. We visited their far-away house.

Sentence. We visited their pop-down-for-the-weekend house.

There are some tricks to the noun and participle modifiers. This week we shall discuss premodification of nouns by nouns; next week we shall do premodification of nouns by participles.

- To write "We visited their country house." is fairly easy and intuitive, but slightly ambiguous, in that we do not know if the author intends to say "We visited their house that is in the country." or "We visited their house, which is in the country". In other words, we don't know from "We visited their country house." if the house is the only house owned by them, or if they own a city house as well, and the premodifier "country" distinguishes the houses. If this distinction is important, it is best to avoid the premodifier.
- Another trouble arises when considering the permanence of the noun in question. "The book is on the table in the corner." easily becomes "The book is on the corner table." because the table is relatively immobile. However, "The girl in the corner has the book." does not readily become "The corner girl has the book." because the girl may easily move from the corner. She is not in the corner often enough to have "cornerness" as part of her character, whereas the table does. So don't use nouns as premodifiers unless the modification has some permanence.
- Finally, when using plural nouns as premodifiers, they are often changed to the singular. Therefore, "the leg of the trousers" becomes "the trouser leg". "The lens of the binoculars" turns into "the binocular lens". Although this change is normal, it is not universal, e.g. "the race of arms" becomes "the arms race", where "arms" stays plural.

Try your new knowledge! Rewrite the following sentences...if you think you should.

1. The sample that was annealed had a nonlinear response.

No change. The sentence distinguishes one sample from others that may exist. (But from this sentence, we don't learn anything about other possible samples.)

2. The sample, which was annealed, had a nonlinear response.

No change. Annealing isn't important here, and it would be confusing to write "The annealed sample had a nonlinear response." because it would imply that there is something special about the annealing process.

Our scientific breakthroughs are, to say the least, debatable.
We laugh at critics haughtily; our egos are inflatable.
The rest of science goes along, Because our last defense is strong:
It's hard to prove we're ever wrong in physics theoretical.
Found at <http://www.sonic.net/~roelofs/humor/theoretical.html>

40 Premodification of Nouns by Participles

Today's topic is the modification of nouns by participles, placing the participle before the noun. For example, in "I visited their cottage, which is charming.", the noun "cottage" is modified by the subordinate clause "which is charming". In the sentence "I visited their charming cottage.", the noun "cottage" is now premodified by "charming". Last week we went over the premodification of nouns by nouns, and you are encouraged to compare the lessons.

As for the case of modification by nouns, we have to watch out for problem of uniqueness. To write "We visited their charming cottage." is fairly easy and intuitive, but slightly ambiguous, in that we do not know if the author intends to say "We visited their cottage that is charming." or "We visited their cottage, which is charming". In other words, we don't know from "We visited their charming cottage." if the cottage is the only cottage owned by them, or if they own an ugly cottage as well, and the premodifier "charming" distinguishes the buildings. If this distinction—the uniqueness—is important, it is best to avoid the premodifier. See the lesson on "that" and "which" if you are unclear about the difference between them.

Participles that end in *-ing* need no further commentary. Participles that end in *-ed* deserve a few more words. "Please give me some tea that is iced." becomes "Please give me some iced tea." In conversation (and in some writing), the *-ed* of "iced" is often dropped, changing iced tea to ice tea. This modifies the sense. It's not tea made of ice, it's tea that has been chilled, i.e. iced, and is now icy. With time and usage "ice tea" becomes acceptable, but I suggest that you avoid all possible ambiguities in your scientific writing. Keep the *-ed*. Try these.

1. He has a mind that is interesting.

He has an interesting mind. There is no trouble with uniqueness because we can safely assume that each person has only one mind. (There may be rare cases in psychology where this does not hold, but we ignore those extreme cases.)

2. He has a mind, which is interesting.

No change. This sentence has a different sense than the one above. In #1, we are impressed by his mind. In #2, we are amazed that he has a mind. Again, this stems from the rather safe assumption that each person has one and only one mind. If we were to change this sentence to "He has an interesting mind.", we change the meaning to that of example #1.

3. Their approach is interesting and warrants longer explanation.

Their interesting approach warrants longer explanation.

4. The approach is convoluted and needs to be clarified.

The convoluted approach needs to be clarified.

5. The interaction is long ranged and cannot account for the observed behavior.

The long-ranged interaction cannot account for the observed behavior. Because long modifies ranged, and not interaction, the hyphen is used to emphasize that together the words 'long-ranged' modify interaction.

6. The nanotubes are multiwalled and adhere strongly to the substrate.

The multiwalled nanotubes adhere strongly to the substrate. I often read "multiwall nanotubes", but this is sloppy. If you intend "the nanotubes fabricated from carbon", you can write "carbon nanotubes", and everyone understands. If you intend "the nanotubes are multiwalled", to write "multiwall nanotubes" implies that they are made of "multiwall". Of course, people are not so stupid to believe that there is a new element called multiwall, but if you have a choice, it's better to be precise. People often associate the precision of your writing expression with the precision of your scientific thinking.

MAGNESIUM THE BEAUTIFUL
(to the tune of "America the Beautiful")
For alkyl halides' majesty
Magnesium is meant,
Assisted by completely dry
E-ther-e-al sol-vent.
Magnesium, Magnesium,
A Grignard has M-g,
It's understood, its bonds are good
>From C to shining C.
A carbonyl is polarized,
Its carbon end is plus.
A nucleophile will thus attack
The carbon nucleus.
Magnesium, Magnesium,
A Grignard has M-g,
Each one is fond of making bonds
>From C to shining C.
Oh, Grignards can make alcohols,
Of types there are but three.
When Grignards add formaldehyde
The product's primary.
Magnesium, Magnesium,
A Grignard has M-g,
Its alkyl group gives out a whoop
As C grabs shining C.
For alcohols, a Grignard and
A carbonyl collide.
A secondary's synthesis
Requires an aldehyde.
Magnesium, Magnesium,
A Grignard has M-g,
And makes a bond to correspond
>From C to shining C.
For tertiary alcohols
An ester captures two,
But if you send a ketone, then

Just one Grignard will do.
Magnesium, Magnesium,
A Grignard has M-g,
We don't need zinc to make a link
>From C to shining C.
Now if you need an acid of
The carboxylic kind,
Just bubble past a simple gas:
To Grignards it will bind.
Magnesium, Magnesium,
A Grignard has M-g,
It sticks like glue to CO₂,
Joins C to lonely C.
One Grignard grabs a nitrile, then
The next leaves it alone.
The product, during workup, hydrolyzes to ketone.
Magnesium, Magnesium,
Is held in high regard
By chemists, who give honor to
Monsieur Victor Grignard.
-modifications by Dan Mettern
University of Mississippi

41 Opportunity and Possibility

This week's lesson concerns the difference between "opportunity" (fr. occasion, de. Gelegenheit) and "possibility" (fr. possibilité, de. Möglichkeit). Non-native speakers frequently confuse them. Here are their definitions.

Opportunity– A favorable or advantageous combination of circumstances; suitable occasion or time.

Possibility–

1. The fact or state of being possible (possible–capable of happening).
2. Something possible.
3. Someone capable of succeeding or being chosen.
4. (Plural) Capacity for favorable development; potential.

"I have the possibility to visit the Pope." has a different sense than "I have the opportunity to visit the Pope." In the former, you imply that your schedule and the Pope's are synchronized well enough such that you may see each other. In the latter, you place great value on your visit with the Pope, you are glad that you will see him, and you consider yourself lucky that you can.

Similarly, telling a graduate in computer science "There are good possibilities in information technology." is different saying "There are good opportunities in information technology." The former draws attention to the dynamic market, and the potential for an individual to make a contribution. The latter emphasizes that the graduate chose her profession in a timely way.

Are these sentences correct?

1. Netscape continues to grow and has many resources. There are many opportunities at Netscape for a bright young person. **NO**
2. Their personnel officer will be interviewing on campus next week. What a possibility! **NO**
3. Unless you pass your exams, there's no possibility that they will hire you. **YES**
4. I have the opportunity to interview you Friday afternoon. **NO**
5. My new job exactly fits my career plan. It's a great opportunity. **YES**

There are three kinds of mathematicians: those who can count and those who can't.

42 Simple Past and Present Perfect Verb Tenses

Today's topic is the difference between the simple past and present perfect verb tenses. The difference is very important in English. The two tenses are important in scientific writing because most of the work we describe takes place before we write about it.

"When I was at the National Renewable Energy Laboratory, I worked on semiconductors," is an example of the SIMPLE PAST tense. My work at NREL is over. It was completed some years ago. Simple past is used for actions that occurred in the past and that are over.

"*At the Swiss Federal Institute of Technology, I have worked on the nanomechanical properties of materials,*" is an example of the **PRESENT PERFECT** tense. I started my work some years ago, but continue it. Most scientific publications are written in the present perfect because you start your work in the past and continue it into the present and perhaps into the future.

There are two more variations on the use of present perfect. One is where the present perfect refers to an event that just happened. "*The Starr report has appeared on the Internet,*" is an example. Yes, it is an event in the past, but if I were to say "The Starr report appeared on the Internet," it would seem less timely. The present perfect emphasizes the newness of the event.

Past events that repeatedly occur into the present are also described by the present perfect. "*Scientific American has arrived at our house for many years.*"

In the sentences below, would you use the simple past or the present perfect?

1. Yesterday I **went** to the movies.
2. Did you hear? Kohl **has won** the election!
3. Our continuing work **has shown** that the molecules obey the worm-like chain model.
4. Last year's work **showed** that the molecules obey the worm-like chain model.
5. My Scientific English lessons **have arrived** almost every week since I first subscribed.
6. When I was a subscriber, my Scientific English lessons **arrived** almost every week.

Twas the night before implementation and all through the house,
not a program was working, not even a browse.

The programmers hung by their tubes in despair,
with hopes that a miracle soon would be there.

The users were nestled all snug in their beds,
while visions of inquiries danced in their heads.

When out in the machine room there arose such a clatter,
I sprang from my desk to see what was the matter.

And what to wondering eyes should appear,
but a super programmer (with a six-pack of beer).

His resume glowed with experience so rare,
he turned out great code with a bit-pusher's flair.

More rapid than eagles, his programs they came,
and he cursed and muttered and called them by name.

On Update! On Add! On Inquiry! On Delete!
On Batch Jobs! On Closings! On Functions Complete!

His eyes were glazed over, fingers nimble and lean,
from weekends and nights in front of a screen.

A wink of his eye and a twitch of his head,
soon gave me to know I had nothing to dread.

He spoke not a word, but went straight to his work,
turning specs into code; then turned with a jerk.

And laying his finger upon the "ENTER" key,
the system came up and worked perfectly.

The updated updated; the deletes, they deleted,
the inquiries inquired, the closings completed.

He tested each whistle, and tested each bell,
with nary a bomb, and all had gone well.

The system was finished, the tests were concluded,
the users' last changes were even included.

And the user exclaimed with snarl and a taunt,
"It's just what I asked for, but not what I want!"

- Anonymous

43 Nuances of Prepositions

Do you know that there are perceptible differences between "with" and "within", "in" and "into", "up", "up on" and "upon"? These are the most frequent examples of how the addition of a small word or a few letters can shift the meaning of a sentence. I list only the most common definitions.

with	accompanied by, in close proximity to
within	inside, in the scope of
in	indicates inclusion within a space, domain, means, temperament, or time
into	the act of being included, toward (indicates motion)
up	to, toward, or in a more elevated position
up on	on top of (emphasis on the position), slang for informed
upon	on top of, immediately afterwards, on the occasion of

The first story (incorrect) below is vastly different from the second (correct).

I went *within* my husband to the movies. *With* the foyer, we bought tickets after standing *into* line. As we went *in* the theater, I noticed some friends sitting *up on* a few rows from us. I asked them "What's this film about? I'm not *upon* modern culture." *Up* hearing this, they laughed at me.

I went *with* my husband to the movies. *Within* the foyer, we bought tickets after standing *in* line. As we went *into* the theater, I noticed some friends sitting *up* a few rows from us. I asked them "What's this film about? I'm not *up on* modern culture." *Upon* hearing this, they laughed at me.

Try them yourself.

1. John lives **up** the hill from Sally.
2. Scott lives higher still, **up on** top of the hill.
3. **Upon** the roof of his house, there is a television antenna.
4. He strode **into** the lecture hall, already **in** an angry mood.
5. We can work **with** them very easily.
6. They have good spirit **within** their group.

I usually avoid political topics for these pages, but today I just can't resist. This extremely well-written Letter to the Editor of the International Herald Tribune was published yesterday.

"There is a kind of urgency about Kenneth Starr, a man who sees himself as a hero, who is so hungry for the taste of righteousness that he will happily settle for false righteousness, and then peddle it relentlessly, without scruples or modesty, to a public he has misjudged."

-Alexa Intrator, Ferney-Voltaire, France

44 Let and Leave

I often hear the verbs "to let" and "to leave" confused. This probably originates from the one case where they are interchangeable—"Let him alone." and "Leave him alone.", meaning allow him to be in peace, are equivalent.

Although "to let" has nineteen different definitions in my dictionary, its primary senses are "to allow", "to allow to remain in the same condition", or "to rent". (This latter is chiefly British.) Examples are—

I will let you borrow my car for one week (to allow).

The apartment on the third floor is for let (to rent).

You are annoying me. Let me in peace (to allow to remain in the same condition)!

"To leave" has 24 different definitions, but these four encompass most of them: "to go away from", "to remain behind after going away", "to be at liberty", and "to allow to remain in the same condition". Examples are—

Leave the house this instant (to go away)!

Leave the book on the table before you go to lunch (to remain behind).

My boss gave me leave next week (to be at liberty).

Don't type on my computer! Leave it alone (to allow to remain in the same condition)!
Try these!

1. When I was in the Army, I could only get **leave** for three days at a time.
2. I'll **let** you use my computer, if you can make sure to **leave** it before 10:00 when I need it again.
3. When you **leave** the office, please turn out the lights.
4. If you know of a house for **let**, please tell me, I need a place to stay.
5. We should **let/leave** her alone while she is preparing her talk.

Said the Bishop of Stockton-on-Tees
to the lady who sat on his knees,
"While I give you a kiss,
you may fiddle with this,
but please not with these."

-author unknown

45 Look Over it, Overlook, Look it Over

Sometimes writing English is easier than understanding the nuances of spoken English. Do you understand the differences between:

I looked over it;

I overlooked it;

I looked it over ?

You would think that the above would mean the same thing, but they don't. These sentences are too informal to be used in writing, but you may hear them at conferences or in conversation with native speakers. The native speakers don't realize how difficult nuance can be.

"*I looked over it*" means that I had a view beyond. For example, from my window, I have a nice view of my neighbor's garden, and I can look over the garden to see my neighbor's house.

"*I overlooked it*" means that I omitted something. For example, in my list of things to buy at the grocery store, I forgot to purchase eggs. I overlooked the eggs.

"*I looked it over*" means that I considered something. For example, if someone wanted my help with a publication or proposal, I might tell them that "I looked it over, and I think...."

I apologize profusely for these kinds of difficulties. English enjoys wide acceptance because it is fairly easy to reach a level where you can communicate. It is also very tolerant of mistakes – the meaning is usually understood even if there are errors. Much imagery is used in informal speech. That's fun for us native speakers, but trying for those who are still learning.

Can you fill in the blanks?

1. Give me your paper and I'll **look it over** over the weekend. (Notice "over" is used twice correctly!)
2. I'm sorry I missed our appointment. I **overlooked it** in my calendar.
3. From Mount Tendre you can see Lake Geneva. I enjoyed my **look over it**.
4. Thanks for the quotation. I'll **look it over**.
5. From the back row of the class I could **look over** his shoulder.
6. I **overlooked** our meeting today. Sorry.

"The advantage of culture is that it enables you to talk nonsense with distinction."

from *Ashenden*, by W. Somerset Maugham (1927)

46 Conjunctions I

Connecting words, or conjunctions, control the flow of a manuscript. They join sentences or parts of sentences in a logical, chronological, or other way. I wrote one lesson on this subject already; see this page. Because it is a difficult subject, I shall devote the next two lessons to it. We can think about conjunctions by the grammatical roles that they play:

Listing

- Enumerative- *In the first place*, the economy is recovering, and *secondly* unemployment is beginning to decline. (*for one thing, for another thing, next, then, finally*)
- Additive- She has the ability, the experience, and *above all* the courage to tackle the problem. (*furthermore, moreover, what is more, similarly, in addition*)

Summative He was late for work, he quarrelled with a colleague, and he lost his wallet; *all in all*, it was a bad day. (*altogether, overall, therefore, in sum, in summary, in conclusion*)

Apositive There was one snag; *namely*, the weather. (*that is, that is to say, i.e., for example, e.g., in other words, specifically*)

Resultative I got there very late, *so* I missed most of the fun. (*therefore, as a result, accordingly, in consequence of, of course*)

Try these. More than one word may be correct.

1. I think she's just the right person for the job. She has the degree, _____ the experience.
moreover, what is more, in addition, furthermore, above all
2. The sample will soon melt. _____ it will flow out of the sample holder.
of course, therefore, as a result, accordingly, in consequence of
3. There is just one small problem. _____ I want to use the instrument tomorrow.
Namely, that is, that is to say, for example, in other words, specifically
4. _____, we have shown that these methods have much in common.
In summary, in conclusion, overall, altogether
5. I don't want to work on the paper today. _____, I have a class and _____ I'm very tired.
**Firstly, first of all, for one thing
secondly, for another thing, also**

The book "A Student's Grammar of the English Language," by Greenbaum and Quirk, Addison Wesley Longman Limited, 1990, was very useful to this lesson.

[Read about this year's Ig Nobel Prizes!](#)

47 Conjunctions II

Following last week's lesson we continue with conjunctions, classifying them by their grammatical roles.

Inferential You haven't answered my question; *in other words*, you disapprove of the proposal. (*in that case, so, then, otherwise, else*)

Contrastive

- Replacive—She's asked some of her friends—some of her husband's friends, *rather*. (*better, more accurately, in other words*)
- Antithetic—They had expected to enjoy being in Manila *but instead* they both fell ill. (*on the contrary, by contrast, on the other hand, then*)
- Concessive—My age is against me; *still*, it's worth a try. (*however, nonetheless, yet, all the same, of course, that said, only, though*)

Transitional

- Discoursal—Let me introduce you to my sister, and *by the way*, did I tell you that I'm moving?
(*incidentally, now*)
- Temporal—The ambulance got stuck in rush-hour traffic and *in the meantime* the child became delirious. (*meanwhile, originally, subsequently, eventually*)

Try these. More than one answer is possible.

1. Last month I _____ thought he was wrong. _____ I agree with him.

originally

Meanwhile, subsequently

2. He asked no questions. _____ was he asleep, or _____ not interested?

So, then, in that case

otherwise, else, just

3. He heated the sample above its glass transition. _____, to 100 degrees Centigrade.

More accurately, better, in other words, rather

4. I'm giving a talk in Germany next month. _____, I'll be there during a special festival.

Incidentally, by the way, now

5. I expected to have a lot of interest in my talk. _____, no one came.

On the contrary, but instead

6. We disagree with the other group's interpretation. _____, their experimental results are impressive.

Still, however, nonetheless, yet, all the same, of course, that said, only, though

The book "A Student's Grammar of the English Language," by Greenbaum and Quirk, Addison Wesley Longman Limited, 1990, was very useful to this lesson.

Ban dihydrogen monoxide!

48 Quiz Question

What is the difference between the sentences below? Try rewriting them to better distinguish between them.

1. Therefore, the resonant frequency of a specimen at the lowest strain amplitude *was used* as the variable F_i .
2. Therefore, the resonant frequency of a specimen at the lowest strain amplitude *used was* the variable F_i .

A small change in word order modifies these sentences a lot. Sentence (1) implies that an assumption has been made and that it was decided that the particular frequency was the correct one to choose. "Was used" is here the passive verb form of "to use". In sentence (2), the "used" refers to the resonant frequency that was employed, and that there are no doubts as to the appropriateness of the choice. "Was" is the verb, in past tense. The sentences could be written as:

1. Therefore, the resonant frequency of a specimen at the lowest strain amplitude **was taken to be (or, was assumed to be)** the variable F_i .
2. Therefore, the resonant frequency of a specimen at the lowest strain amplitude **that was used** was the variable F_i . (Or, therefore, the resonant frequency of a specimen at the lowest **used** strain amplitude was the variable F_i .)

A mathematician and a physicist agree to a psychological experiment. The mathematician is put in a chair in a large empty room and a beautiful naked woman is placed on a bed at the other end of the room. The psychologist explains, "You are to remain in your chair. Every five minutes, I will move your chair to a position halfway between its current location and the woman on the bed." The mathematician looks at the psychologist in disgust. "What? I'm not going to go through this. You know I'll never reach the bed!" And he gets up and storms out. The psychologist makes a note on his clipboard and ushers the physicist in. He explains the situation, and the physicist's eyes light up and he starts drooling. The psychologist is a bit confused. "Don't you realize that you'll never reach her?" The physicist smiles and replied, "Of course! But I'll get close enough for all practical purposes!"

49 Hyphenation

Hyphens are commonly used to break up a word at the end of a line. The remainder of the word appears on the following line. This function is usually done correctly by modern word processors. A second, more difficult application of hyphenation comes when forming compound words. Let's examine these examples:

Scientific American English
Scientific-American English
Scientific American-English
Scientific-American-English

The first example, Scientific American English, is hard to interpret because we don't know how to group the words and extract the meaning. This is also true for the last. The second, Scientific-American English, concerns the kind of English found in the monthly magazine *Scientific American*. The third, Scientific American-English, concerns the English spoken to the West of the Atlantic in a scientific context. The small hyphen has a powerful influence on meaning.

In order to place the hyphens correctly, ask yourself which words belong together. In the second example, the words Scientific and American act together to modify the noun English. In the third example, American and English together define a specific regional style of English.

Typically, hyphens are helpful when two nouns together, or an adjective and a noun together, modify a third noun. How would you hyphenate the following...or would you?

1. grain-boundary sliding
2. long-ranged interaction
3. tip-sample interaction
4. at high frequencies and low amplitudes of excitation **NO HYPHENS**
5. low-frequency high-amplitude measurements
6. in the direction of the top to the bottom **NO HYPHENS**
7. the bottom-to-top direction
8. the free electronic Scientific-English lessons

*Blessed are they who can laugh at themselves,
for they shall never cease to be amused.*

-author unknown

50 Verbosity

Verbose is an adjective that means "characterized by use of too many words." You do not want verbose, flowery, wordy, superfluous, redundant, excessively descriptive manuscripts. Better they be terse and pithy. The following two examples highlight the effect of excess verbiage.

"We spent all of the entire morning caulking the boat for the purpose of making it water-tight. That was the first time I had done that in my entire life." (32 words)

"We spent all morning caulking the boat, a new experience for me." (12 words)

It's not always easy for a non-native speaker to shorten and simplify text. But you can seek out phrases that can be replaced by a single word. The phrases below can be replaced by because, now, approximately, about, although, or soon.

1. in the not-too-distant future = **soon**
2. at the present writing = **now**
3. in light of the fact that = **because**
4. concerning the nature of = **about**
5. in the neighborhood of = **approximately**
6. despite the fact that = **although**

Inspiration for this exercise was taken from "Getting the Words Right", by T.A.R. Cheney, Writer's Digest Books, Cincinnati (1990).

A philosopher, a physicist and a mathematician are scheduled to prove their survivability. Therefore they are to be incarcerated in different cells, each having a closed can of corned beef and no can opener.

The philosopher goes first. After two weeks, the cell is opened and the philosopher is found dead, the can still closed. He must have died thinking about a way to open it.

The physicist goes second. Two weeks later he is found with the whole wall filled with formulas, munching happily on his corned beef.

Last goes the mathematician. Two weeks later the door is opened. The can is still there, untouched but the mathematician has disappeared. Suddenly the jailor hears a knocking from inside the can. After he opens the can, he discovers the mathematician sitting inside, scratching his beard and mumbling, "There must have been something wrong with the prefix."

-submitted by Ernst Schnell

51 Some Useful Latin Words

Latin raises its ancient hand in scientific English. Here are some of the more commonly used Latin words.

<i>ad hoc</i>	for the special purpose or end
<i>anno Domini (A.D.)</i>	in the year of our Lord; a date after Christ
<i>ante meridiem (a.m.) post meridiem (p.m.)</i>	before noon after noon
<i>circa (ca.)</i>	about used especially in approximate dates
<i>et alia (et al.)</i>	and others; and elsewhere
<i>et cetera (etc.)</i>	and others; and so forth; and so on
<i>exempli gratia (e.g.)</i>	for example; such as
<i>ibidem (ibid.)</i>	in the aforementioned place
<i>idem</i>	the same as previously given
<i>id est (i.e.)</i>	that is
<i>in situ ex situ</i>	a. in place or position; undisturbed b. in a localized state or condition the opposite of <i>in situ</i>
<i>opere citato (op. cit.)</i>	in the work cited (In other words, <i>op. cit.</i> means that you don't know the page number.)
<i>sic</i>	thus; so. Used to indicate that a surprising word in the text is not a mistake or is quoted verbatim.
<i>vice versa</i>	conversely; in reverse order from that stated
<i>vide</i>	see
<i>vide ante vide infra vide post vide supra</i>	see before see below see after see above
<i>videlicet (viz.)</i>	that is to say; namely

Do you know how to use them correctly? More than one answer may be right.

1. This concept was explained earlier in this chapter (**vide** p.342).
2. The paper by Smith **et al.** disagrees with your findings.
3. The experiment was performed **in situ or ex situ**.
4. Friction is manifest in everyday life: the brakes of cars, skating on ice, **etc.**
5. For the moment, we concentrate on explaining the first effect (_____ for the second effect).

vide ante, vide infra, vide post, vide supra

6. I. Can B. Funny, The Journal of Irreproducible Results 42, 300 (2000); **idem or ibid.** p. 412.
7. I. Can B. Funny, The Journal of Irreproducible Results, **op.cit.** (2000).
8. I have many meetings today, **i.e. or viz.**, students at 11:00, lunch at 12:30, and class at 15:00.
9. I have many meetings today, **e.g.**, students at 11:00.

10. He was born **ca.** 40 B.C. (Before Christ)
11. He was born 32 **A.D.**
12. I'll meet you at the train station at 3:00 **a.m. or p.m.**
13. He signed his name as e.e. cummings (**sic**).
14. He likes me and **vice versa**.
15. The committee was formed **ad hoc** to look into that problem.

At the atomic level, we have new kinds of forces and new kinds of possibilities, new kinds of effects. The problems of manufacture and reproduction of materials will be quite different. I am, as I said, inspired by the biological phenomena in which chemical forces are used in repetitious fashion to produce all kinds of weird effects (one of which is the author).

-R.P. Feynman, 1959

52 Utilize and Use

If you are already comfortable with your English, but you would like to refine it, then I suggest that you read "Getting the Words Right", by T.A.R. Cheney, Writer's Digest Books, Cincinnati (1983). It treats editing, and even after all my experience I learned a lot. Moreover, it is a joy to read. This passage concerning the difference between utilize and use is an example of his style.

"It would be difficult to find a page of governmental, military, or academic writing that doesn't have on it the word *utilize*. It must be one of the most over-utilized words in the world. It seems as though people out to impress people with the significance of what they're doing use *utilize* when they should use *use*.

Utilize is not an elegant variation of the word *use*; it has its own distinct meaning. When you utilize something, you *make do with something not normally used for the purpose*, e.g., you *utilize* a dime when the bloody screwdriver is nowhere to be found. If the screwdriver were there, you'd *use* it, not *utilize* a stupid dime for the purpose. Use *use* when you mean *use*, and *utilize* only when it's properly used to mean *to use something not normally used*. The computer went off-line, so they *utilized* Mr. Wang's abacus, the one he liked to *use*. Despite the temporary breakdown, the computer's *use*-rate was up (not its *utilization*-rate)."

Searching in several sources, I found that Mr. Cheney lands in the minority with his definition of utilize. Most dictionaries equate utilize and use. But I do agree that utilize is *overused* (not *overutilized*), simply because it is a long and bureaucratic word, where a simple one projects the same meaning for fewer letters. Don't "utilize" *utilize*. Use *use*.

Try some examples, *using* Mr. Cheney's definitions of utilize and use.

1. **Utilizing** some string, I tied down the trunk of the car.
2. A camera was **used** to record the scene for future generations.
3. Putting the wrench to good **use**, I was able to fix the car.
4. A clever **utilization** of the tools at hand, the axe held down the tent on that windy day.

Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful.

*-E.F. Schumacher, an economist,
in "Small is Beautiful,"
Harper Perennial (1989)*

53 Prepositions—For Sale, On Sale

Oh, how a tiny word can change the meaning of sentence! Prepositions, which we've studied before, have enormous influence on the sense of text. Unfortunately, they are very difficult to learn. Let us take just one example today, that of the difference between "for sale" and "on sale". It may be useful to know the difference if you would like to purchase supplies from an English-speaking distributor.

For sale, offered to be sold; made available to purchasers.

On sale, able to be bought at reduced prices.

If something is *for sale*, you can buy it. If something is *on sale*, you can buy it at a discount.

Try these examples.

1. Student A: "I need to buy a widget." Student B: "Go to Jumbo. They have them **for** sale."
2. Student A: "I bought my new skis for 900 Swiss Francs." Student B: "Hah! I got mine **on** sale for 450 SF!"
3. Often stores perpetually have **On Sale** signs in their windows, even if the items might not be discounted, and they should be displaying **For Sale**. Sometimes they will simply show Sale, in which case they imply **On Sale**.

*What would the properties of materials be
if we really could arrange the atoms the way we want them?*

*-R.P. Feymann
1959 APS Meeting*

54 Lay and Lie

"Lay" and "lie" are frequently confused by native and non-native speakers alike. You lie in bed. But you lay the book on the table. You can equate "lay" with "put" and "lie" with "rest". You rest in bed. You put the book on the table. Germans will find them easier to distinguish because of their concepts of the accusative and dative cases. The accusative case, which indicates motion, corresponds to "lay"; the dative, or immobile case, corresponds to "lie".

Try it!

1. **Lay** the sample on the sample holder. Then we'll let it **lie** there overnight.

New physics bumper sticker (written in red)–

If this sticker is blue, you're driving too fast.

55 As, Because, Since

As, *because*, and *since* overlap in meaning. This can lead to confusion, because *since* and *as* have alternative definitions. *Since* also means "from a past time up to the present", and *as* has many (at least 32!) alternative definitions, including:

1. to the same degree, amount, or extent; similarly; equally
2. for example; for instance
3. thought to be or considered to be
4. in the manner of
5. at the same time that

Because is the only unambiguous one of the three. It means "for the reason that" or "by reason of". (Never use the redundant phrase "the reason is because".)

Consider—

- A. I didn't hear her enter as I was concentrating.
- B. Since the instrument broke, I've been very busy.

Does A mean that because I was concentrating, I didn't hear her enter, *OR* does it mean that she entered at the same time that I was concentrating? Similarly, for B, have I been very busy because the instrument broke, *OR* busy just in the time after the instrument broke until now? My suggestion is to use *as* sparingly in your texts, solely for variety from *because* and *since*. Look for ambiguities, particularly in time.

Try finding the least ambiguous answer to put into the sentences below.

1. **As (= in the manner of)** in the kitchen, we are now going to cook up a sample.
2. **Since** the first of the year, I was in America four times.
3. **Because** you left the door of the refrigerator open, we will lose all our food.
4. **As (= to the same degree)** fat as the Titanic, he couldn't fit through the door.

For sentence 4, you could also write "Because he was as fat as the Titanic, he couldn't fit through the door." Here, the emphasis lies on the casual relationship between being overweight and movement. The intention of 4, however, was to invoke imagery and relate an event. "He was as fat as the Titanic. He couldn't fit through the door." The construction of the sentence gives a strong clue that *as* is the best answer.

Stop Physics Hooliganism:

collapsing state vectors
symmetry breaking
degeneracy
turbulence
chaos

56 Accuracy and Precision

In some languages, there is no distinction between accuracy and precision. But in scientific English they mean different things. Accuracy is the degree to which a result agrees with the theoretical value. Precision indicates how well that result can be repeated. If you think of archery, an accurate imprecise archer will shoot a series of arrows; the average of the series of shots will be the center of the target, but the individual arrows are scattered over the target's surface. A precise inaccurate archer will be able to repeat the position of the arrows very well, but the position of the arrows averaged over a number of shots will be far from the center of the target. A precise accurate archer hits the center of the target every time. Both accuracy and precision are useful to know when evaluating experimental results, especially when introducing a new technique or measuring fundamental constants.

Do the sentences below indicate accuracy, precision, or both?

1. As the gun warmed up, it was hard to repeatedly hit the target.
precision
2. The students reported that the speed of light is 2×10^8 m/s, an error of -33%.
accuracy
3. The rest mass of the neutron is 1.008 665 012 amu (atomic mass units) with 0.037 ppm (parts per million) error.
accuracy and precision
4. Our mean value was 50 GPa; our standard deviation was 5 GPa.
precision
5. The R value from the least-squares fit was 0.987.
precision
6. We used a standard to calibrate our instrument. We think that the values we obtained are good to within 5%.
accuracy
7. If you can measure the fine structure constant to three significant figures (137), then you don't have a very good instrument. However, if you can measure it to nine significant figures (137.035 963), then I want to see your lab!
precision
8. The reproducibility of the experiment is a few degrees Centigrade. The temperature can be measured to plus or minus five degrees.
accuracy and precision

New Physics Bumper Sticker:

Don't drink and derive. $E = mc^2$.

57 Access and Assess

The words *access* and *assess* could easily be confused in scientific writing. They sound almost the same and are spelled similarly, but they have different meanings. *Access* means the ability or permission to approach, enter, speak with, or use. *Assess* means to evaluate, to fix a value, or to impose a tax upon. Both are transitive verbs, in other words, they require an object. They can be made into adjectives—*accessible* and *assessable*. *Access* is also a noun, but *assess* is not (although *assessment* is).

A few examples:

The images allowed us to *assess* the severity of the problem.

The room at the top of the stairs is not *accessible* by wheelchair.

I just installed my computer. I don't yet have *access* to the Internet.

Although this phenomena is complex, it is *assessable*.

Try these yourself..

1. He gave me **access** to the lab.
2. Could you please **assess** this paper?
3. Your server is not **accessible** by my computer.
4. This technique should give us **access** to the problem. Then we can make an **assessment** of how well we understand the phenomena, and what experiments we should do next month.

What do psychologists say to each other when they meet?

"You're fine, how am I?"

58 Long Manuscripts

Your first long manuscript may be a thesis. Not only is more effort required merely because of its length, but also more effort should be put into its organization. Here are some hints.

1. Remember that not everyone will read every word of your long document. Or they may read it carefully one time, then use it later as reference material. You want the titles of the subsections to be sufficiently clear so that people may return easily to your manuscript and find the information they need.
2. Similarly, each figure should demonstrate an important point, and the figure captions should contain enough information such that the reader can grasp the major ideas of the work just by glancing at the figures. Any terminology that appears in a schematic should be explained in the figure caption. For a thesis, there should be enough background information within the text to be able to interpret each figure.
3. Longer documents require more time for the reader to digest. Help the reader by providing a good introduction that contains not only the historical and contextual background, but also gives an overview of the work and describes how you organize the information within the manuscript. (To use an analogy from Prof. W. Benoit, the overview is like your first view of a magnificent cathedral – the total impression is breathtaking. Then you look more closely for the details – the rest of the text.)
4. The distinctions among background information, your data, and your interpretation should be clear. People want to know what YOU have done. They may also return in a few years with a new interpretation, in which case they would want to review your data free of your interpretation.
5. For a Ph.D. thesis, you have two audiences. One is the next Ph.D. student who may try to take your work further. Write the background information and experimental results for her. These sections should be written very simply and clearly, assuming a low level of experience in your domain. The experts in your field, who will evaluate your thesis, comprise the other audience. The overview and the interpretation are for them. Write these sections assuming good knowledge on the part of the reader.
6. Ensure consistency between different parts of the manuscript by making a list of the mathematical symbols that you use. It is easy to forget in Chapter 5 in the midst of using "t" to mean time that you already used "t" to mean temperature in Chapter 2.
7. It helps to emphasize definitions and key ideas using boldface, italics, etc. My personal preference is to use boldface for key ideas and italics for definitions, or vice versa. Avoid using one form of font emphasis for both key ideas and definitions.
8. Try not to define acronyms in section titles. Don't put references there either. This makes the manuscript look cleaner.

The heaviest element known to science was recently discovered – Administratium!

59 Adjective or Adverb?

"In Figure 4, the subdomains oriented perpendicular to the scan direction (more specifically, those with their tilt direction perpendicularly to the scan direction)...."

Do you recognize the two small mistakes in the phrase above? They concern perpendicular and perpendicularly, an adjective and an adverb, respectively. It isn't always easy to distinguish between an adjective and an adverb, and thus to use them correctly. Examples:

I caught an *early* train. (Early is an adjective.)

We finished *early* today. (Early is an adverb.)

That was a *kindly* gesture. (Kindly is an adjective.)

Would you *kindly* refrain from smoking? (Kindly is an adverb.)

One test to help determine if a word is an adjective is to try and use it in predicative form, that is:

The train is *early*. (OK, adjective)

Today is *early*...? (definitely not an adjective)

The gesture was *kindly*. (OK, adjective)

Smoking is *kindly*...? (Here there could be debate!)

Now we apply this test to the initial example.

The tilt direction is *perpendicular*. (OK, adjective)

The subdomains are *perpendicular*. (Hmm, perpendicular to what?)

The subdomains are oriented *perpendicularly*. (much better, adverb)

The corrected version of the initial phrase is "In Figure 4, the subdomains oriented *perpendicularly* to the scan direction (more specifically, those with their tilt direction *perpendicular* to the scan direction)...."

There are four characteristics of an adjective. An adjective can:

1. be used in a predicative form, "The train is early."
2. perform an attributive function, as in "the early train..."
3. be premodified by "very" – "the very early train."
4. be made into comparatives and superlatives, e.g. "earlier" and "earliest".

Use these characteristics to help you determine if the word in question is an adverb or an adjective. Most adverbs take "ly" as a suffix.

Are the sentences below correct? If not, how should they be written?

1. The derivation was easy debated. **easily debated**

2. The easy derivation was debated. **OK**
3. The slope of the second curve is steeper than the first one. **OK**
4. The slope drops off more steep. **steeply**
5. Preliminary results were previously published. **OK**
6. Previous results were too preliminary. **OK**

We are grateful to Delphine Gourdon for the uncorrected initial example and to "A Student's Grammar of the English Language" by Greenbaum and Quirk (Longman Press, 1990) for clarifications and other examples.

Physics is like sex: sure, it may give some practical results, but that's not why we do it.

-attributed to Richard Feynman