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Faculty of Science and Technology

English course handout

For
Science and Technology Levels

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Essentials of Technical English

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III - Reading skills

Introduction

The Technical English for Electrical Engineering Students course is designed for undergraduate electrical engineering students whose native tongue is not English. This course uses basic simple backgrounds to support the development of language, reading, and writing skills.

This polycopy is intended to be used as a manual by different levels in the area of science and technology. It was written to enable students to have a working and reference tool that would retrieve the necessary knowledge. The manuscript is made up of courses, and it follows the programs approved by the ministry. Its didactic presentation is the result of the author's extensive teaching experience. His content is the result of reading numerous books and documents, the most significant of which are cited in.

This manual consists of three sections: grammar fundamentals, confusing words, and reading skills. In grammar fundamentals, the principle purpose of this section is to show students how to use the grammar they may face in technical language. For the second section confusing words, students encounter a short explanation to make the difference between them. In the last section reading skills and building vocabulary, following each passage, in understanding text, some activities give students the chance to clarify their understanding of the text. These activities based on comprehension questions and text exploration.

I - Grammar fundamentals

1. Order of Words in a Simple Statement

Look at this group of words: The boy closed the door.

This group of words is called a sentence; a sentence can be:

- **Statement**: The boy closed the door.
- **Question**: What time is it?
- **Exclamation**: What a beautiful flower it is!
- Or a **command**: Open the window.

1. Simple Statements

A statement is a clear expression of something in speech or writing (in this case in writing).

A statement tells us about **one thing** (contains **one** idea) or **two things and more** (contains **two ideas or more**). The statement which contains **one idea** is a simple statement.

The order of words in a simple statement is very important. Look at these two statements. They both contain the same words but they do not have the same idea.

The police arrested the criminal.

The criminal arrested the police.

2. Parts of a Simple Statement

A simple statement can have two, or three, or four, or five, or even up to up to six parts. Study the order of words in the following table. Notice that Column 6 (When?) can be placed both at the beginning and end of a statement.

Statements:

- Now, it is raining heavily.
- It will be sunny in some parts of the country.
- This morning, the little boy ate an apple greedily in the kitchen.
- My neighbors have moved into a new house.
- He does a lot of work everyday
- You must not cross the street carelessly.

6	1	2	3	4	5	6
When?	**Who? What?**	**Action**	**Who? What**	**How?**	**Where?**	**When?**
Time	**Subject**	**Verb**	**Object**	**Manner**	**Place**	**Time**
	It	is raining		heavily		now
	It	Will be		sunny	in some parts of the country	
This morning	the little boy	ate	an apple	greedily	in the kitchen	
Two weeks ago	My neighbors	moved			into a new house	
	He	does	A lot of work			everyday
	You	must not cross	the street	carelessly		

Practice

Do the same thing with the following statements. There is a line under each group of words. The groups of words are not in the right order. Arrange them as indicated in the table above.

Look at this example: to Tunisia She last year went. The right order is:

She (who) went (action) to Tunisia (where?) last year (when?) or

Last year, (when?) She (who) went (action) to Tunisia (where?)

1. Games the children in their room played yesterday
2. This morning a book she from the library borrowed
3. Always in the afternoon you have work do so much?
4. Rarely she at night late goes out
5. My mother to market last week went
6. Continuously the children questions asked this morning in class
7. We at home stay on Sundays
8. During breakfast the newspaper quickly he read

2. ‘There is’ and ‘There are’

- **Look at these examples:**

  There is one cookie left.

There are many cookies left.

1. Use:

We use ‘there is’ to state that something exists or is present.

We use ‘there are’ to state that many things exist or are present.

2. Form:

- **Singular**: There is + rest of the sentence. Example: There is an apple on the table.
- **Plural**: There are + rest of the sentence. Example: There are many apples on the table.
- **Question**: Is/are there + rest of the sentence. Example: Is there an apple on the table?

  Or: Are there any apples on the table?
- **Contraction form**: There is → there’s: There’s a book in the bag.

  There are → there’re: there’re a lot of books in the bag.

Practice:

Fill in the blanks with ‘there is’ or ‘there are.’

1. A: Let’s go out for lunch. Where can we eat?

B: _____ a great restaurant nearby.

2. A: Where can I make a phone call?

B: _____ a phone at the bus station.

3. A: Where can I find a good book?

B: _____ a lot of books at the library.

4. A: Where can I get a taxi?

B: _____ many taxis over there.

5. A: What can I read?

B: _____ a magazine in the drawer.

6. A: What can we do now?

B: Well, _____ a good movie on TV tonight. It’s a mystery film.

7. A: Where can I buy a newspaper?

B: _____ a newsstand on the corner.

8. My sister is having a party tonight. _____ about 30 people coming.
9. I go to a large school. _____ 114 teachers and 1,500 students.
10. Watch out! _____ a big dog behind you, and it is aggressive.
11. We need more dishes on the table. _____ only two and four people are coming.
12. _____ many glasses in the kitchen.

3. Demonstratives
This, That, These, Those

- **Look at these examples:**

A: Is **this** your pen? B: No, **that** is my pen.

A: Are **these** your glasses? B: No, **those** are my glasses.

1. Use:

We use 'this', 'that, 'these', and 'those' to indicate or show specific objects.

2. Form:

- **This/that**: We use 'this' and 'that' for singular objects (one object). Example: this or that book (one book only)
- **These/those**: We use 'these' and 'those' for plural objects (two or more object). Example: these or those books (many books).
- **This/these**: We use 'this' and 'these' for objects **near** the speaker.
- **That/those**: We use 'that' and 'those' for objects **far away** from the speaker.

Examples:

I am going to visit my friends **this** week.

That mountain is too far away. We cannot reach it easily.

These tables are dusty.

He says dreaming: one day, I will live among **those** stars.

Practice:

Fill in the blanks with 'this', 'that, 'these', or 'those.'

1. A: Is _____ coffee still hot?
2. _____ magazines are new.
3. I can carry _____ box. You carry _____ one.
4. _____ are my shoes, aren't they?
5. _____ are my socks and _____ is my tie.
6. _____ are my sons playing football in the yard; but _____ is my dear daughter.
7. There are a lot of people in _____ store.
8. Is _____ a CD player?
9. _____ is my desk. _____ one is yours.
10. I open _____ window and you open _____ window at your right.

4. Nouns

Singular & Plural Noun

- **Look at these examples:**

The **girl** is beautiful

Constantine is a nice city

This **watch** is very expensive

'girl' is a person, 'Constantine' is the name of a place, 'watch' indicates a specific object. They are **nouns**.

1. Use

Nouns are the name of people, places, and things: man (person), New York (place), and watch (thing) are names.

We use nouns to ***identify*** (put names to) people, things, and qualities in the world around us: house, sky, hope, food, intelligence…

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2. Form

- **Singular nouns:** In its singular form, a noun refers to just **one** person or **one** thing: room, flower, boy, man…

- **Plural nouns:** In its singular form, a noun refers to two or more persons or two or more things: rooms, flowers, boys, men…

3. Spelling: How to make a plural noun?

- For most nouns, to make a plural noun add **'s'** to the noun. Example: one guitar, many guitars.
- Many nouns do not take 's' in their plural form; they have spelling changes. Example:

a man → many men a foot → many feet

a box → many boxes a tomato → many tomatoes

a thief → many thieves a watch → many watches

General rule:

- When the singular noun ends with **s, ss, x, sh, ch;** add **'es'.**
- When the singular noun ends with a **Consonant + 'y';** change the **'y'** to **'i'** and add **"es'.**
- When the singular noun ends with an **o;** add **'es'.** Exceptions, however, exist.
- When the singular noun ends with **f, fe;** change the **'f'** to **'v'** and add **'es'.**
- Other nouns take a completely different form in the plural.

Summary:

Singular ending with	**Plural**	***Example***
s, ss, x, sh, ch	Add 'es'	Glass → glasses; dish → dishes Box → boxes
Consonant + 'y'	Change 'y' to 'i' and add 'es'	Baby → babies
O	Add 'es' sometimes	Potato → potatoes **but** Radio → radios
F, fe	Change 'f' to 'v' and add 'es' or 's'	Shelf → shelves Knife → knives
Other nouns	Look completely different	Person → people Mouse → mice Woman → women

Practice

Use the plural form where indicated.

1. I am going to the supermarket to buy some potato ___ and banana ___.

2. Can you buy me two film-roll ___ and some battery ___ for my camera?
3. The student ___ in the afternoon and evening class ___ are having exam___.
4. The menu ___, knife ____, and glass ___ are on the table.
5. She is reading two mystery ___ and three love story ___.
6. There are three sandwich ___ and two bottle ___ of milk in the kitchen.
7. There are two bus ___ and four taxi ___ near the hotel.
8. The egg ___ are in those box ___ over there.

Complete this table. (We have done the first ones to help you)

Singular	***Plural***	**Singular**	**Plural**	**Singular**	**Plural**
Office	*offices*	tomato		princess	
Leaf	leaves		women		holidays
Loss		penny		symphony	
	potatoes		feet		princes
Roof		son-in-law		donkey	
	mice	step-mother		fly	
Key			lives		days
	teeth	rabbit		criterion	
sandwich			species		phenomena
City		sheep			media
Child			series	analysis	
House		chair		basis	
	horses	path			crises
Match			heart		stimuli

5. Possessive Nouns

- **Look at these examples:**

Look at the boy's pizza—the pizza belongs to the boy.

My neighbor's daughter is beautiful—she is the daughter of my neighbor.

The table's leg is broken—the leg of the table.

1. Use:

We use the possessive nouns to show whom or what a thing belongs to.

We use it also to show the relationships that exist between people.

2. Form:

- For single nouns: Add apostrophe and ‘s’ (**’s)** to the name of the person or thing that the noun belongs to.

Example: The **boy’s** pizza (the pizza belongs to the **boy**)

- For plural nouns: Put the apostrophe (**’**) after the ‘**s’**

Example: The **boys’** pizza (the pizza belongs to the **boys**)

Exception:

For plural nouns not ending in s, add **’s.**

Example: a woman’s dress women’s dresses

Practice

Indicate possession for the nouns between brackets

1. Those are my (wife) shoes. ……..
2. He is my (grandfather) brother. ……..
3. This is the (nurse) desk. ……..
4. That is my (mother) idea! ……..
5. This is not my (son) fault, it’s your (brother). ……..
6. My (sister) school is international; the students are from different country.
   ……..
7. This is the (waitress) handbag and that is the (cook) wallet. ……..
8. Those are my (brothers) pants and those are my (sisters) dresses.
   ……..
9. Patty has her (mother) beautiful eyes. ……..
10. He has his (father) bad character and his (mother) intelligence.
    …….

6. The Articles
Indefinite & Definite Articles: a, an, the

- **Look at these sentences carefully:**

Yesterday, I saw **a man** in the street.

The man I saw yesterday was reading **an** article in a newspaper.

'a' *, '***an'** *and* ***'the'*** *are articles; we use them with nouns. We say: a house, the moon (house and moon are nouns).*

1. Nouns

There are different types of nouns: Countable and uncountable nouns, defined and undefined nouns, and abstract nouns.

- **Countable and Uncountable Nouns**

Nouns can be **countable.** 'Horse' for example is a countable noun; we **can** count horses. We say: one horse, two horses, three horses…

Nouns also can be **uncountable,** meaning we **cannot** count them. We cannot count 'sugar', 'rain', ink, 'oil'…

- **Defined and Undefined Nouns**

Nouns can be defined. We refer to things that we know; they are specific or known to us. Example: **The house** of my brother (I know the house, it is the house of my brother).

Nouns can also be undefined. We refer to things that we do not know; they are vague or unknown to us. e. g.: I am planning to buy **a house** (I do not refer to any particular house. I have no clear idea about it; it is simply a house).

- **Abstract Nouns**

Other nouns are classified as abstract nouns. The abstract nouns are intangible; they are not concrete (we cannot touch them, we cannot see them). 'Silence', 'air', 'joy' are abstract nouns.

2. Articles

There are two types of articles: Definite and indefinite. **'The'** is a definite article; **'a'** and **'an'** are indefinite articles

a) Use of articles:

'a' or **'an'** is used with all singular, undefined, and countable nouns.

'the' is used to refer to defined nouns (specific), singular and plural, countable and uncountable.

Examples:

- I want a book (singular, undefined, and countable noun)
- I want the blue book (book is singular, defined, and countable)
- I want the books you promised to give me (books is a plural noun, defined, and countable)
- I want water, please; or I want the fresh water, please (water can not be counted so only 'the' can be used and not 'a')

b) Form:

Nouns that begin with a consonant take 'a'

Nouns that begin with a vowel take 'an'

Examples:

- Give me **a** sandwich, please. (sandwich begins with 's', a consonant)
- This is **a** dog. (dog begins with 'd', a consonant)
- This is **an** orange. (orange begins with 'o', a vowel)

- He gave me **an** apple. (apple begins with 'o', a vowel)

Practice 1

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.

Practice 2

Put the appropriate article (a, an) in front of each word.

___ Soap	___ Picture	___ Egg	___ Milk
___ Box of soap	___ Money	___ Woman	___ Glass of milk
___ Window	___ Ice cube	___ Bus	___ Diamond
___ Health	___ Sand	___ Water	___ Newspaper
___ Cloud	___ Ice	___ Chocolate	___ Umbrella
___ Secretary	___ Chocolate bar	___ Uranium	___ Computer
___ Diamond stone	___ Butter	___ University	___ Orange drink
___ Bottle of ink	___ Comb	___ Meat	___ Cup of Tea

Practice 3

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. **An** Auger electron spectrometer (AES) was employed....
11. **An** AES was employed....
12. **An** X-ray (EX-RAY) photoelectron spectrometer (XPS) revealed...
13. **An** XPS (EX-PEE-ES) revealed...
14. Use of **a** scanning electron microscope (SEM) showed...
15. Use of **an** SEM showed....
16. We used **a** fourier-transform infrared spectrometer (FTIR) to determine...
17. We used **an** FTIR (EF-TEE-EYE-ARE) to determine...
18. **An** ultra-violet photoelectron spectrometer (UPS) displayed....
19. **A** UPS (YEW-PEE-ES) displayed...

7. The Articles: Summary
Some & Any

1. Articles: Summary

Nouns	*Example*	*Defined (the)*		*Undefined (a/an)*	
		Singular	*Plural*	*Singular*	*Plural*
Countable	Horse, table, cat, apple, pencil, girl, car, bird…	**The**	**The**	**A/an**	**No article**
Uncountable	*Oil, sugar, butter, water, gold, smoke…*	The		***No article***	
Abstract	*Health, noise, air…*	***No article*** *(Except when the abstract noun is clearly defined in a sentence)* *e.g.: Health is wealth* *The health of the nation*		***No article***	

2. Some, any

- **Look at these sentences carefully:**

Give me **some** bread, please.

Is there **any** bread left?

There is not **any** bread left.

Use

'Some' *and* ***'any'*** *are used with nouns.*

- ***Some*** *is used in affirmative sentences: There is some water in the bottle.*
- **Any** is used in negative and interrogative sentences: there are not any people in the street; are there any people in the street?
- **Some** and **any** are used with countable and uncountable nouns to indicate an indefinite number or an indefinite quantity: some girls, some butter…

Note: Some is often vague and intentionally indefinite.

e.g.: Come and see me some day next week (the invitation is not precise; it is indefinite; it is not intentional—not serious)

Examples:

- Affirmative sentences: There are some books on the table (number)

  There is some butter in the dish (quantity)
- Negative sentences: there are not any books on the table
- Interrogative sentences: are there any books on the table?

Practice

1. Fill in the blanks with the missing articles.

1. I see _____ wallet on the ground. Is it yours?
2. What is _____ address of Fred's Furniture Store?
3. I want _____ hamburger for lunch.
4. Peter is traveling in France. He is _____ tourist.
5. Where is your TV? It is in _____ living room.
6. My sister is _____ salesperson at Lacey's Department Store.
7. I am not hungry. I am only having _____ egg for breakfast.
8. I am not swimming today. _____ water is cold.
9. What is _____ price of that sweater?
10. I am hungry. I am going to have _____ piece of bread with _____ marmalade.

2. Fill in the blanks with **a, some,** or **any**

1. There are _____ books on the shelf
2. The boy is drinking _____ cup of milk
3. Do you want _____ sugar?
4. There aren't _____ people in the street
5. Tom has bought _____ new car
6. We have _____ apple trees in our garden

3. Again fill in the blanks with the appropriate article.

1. That was _____ good lunch! Let's get _____ check.
2. Clara is _____ actress. She is making _____ new movie. The movie is _____ science fiction story.
3. Julie has _____ beautiful house. _____ house has _____ large living room.
4. A: "Give me _____ pen, please."

B: "Do you want _____ blue pen?"

A: "No, _____ red one, please."

5. A: "I am looking for _____ book about the USA."

B: "Are you looking for_____ travel book?"

A: "Yes, I am."

B: "_____ travel books are over there."

8. Personal Pronouns

Subject and Object Pronouns

- **Look at these sentences carefully:**

I am listening to music.

Bernadette is fat. **She** eats a lot of food every day.

I saw a group of tourists yesterday; I saw **them** yesterday

We have a meeting with the director; **he** is going to meet **us** at 10 o'clock.

'**I', 'she', 'them', 'we', 'he'**, and **'us'** are personal pronouns.

Use

We use pronouns to refer to specific or general nouns without using their names. There are three types of pronouns: Subject pronouns, Object pronouns, and Possessive pronouns (for possessive pronouns see lecture 9).

1. Subject pronouns

They are used to refer to the subject of a sentence without using names.

They are: **I, you, he, she, we, they** are used to refer to persons;

it, they are used to refer to objects and animals.

Example: **I** am Mike, **she** is Matilda, and **he** is little Tommy. **We** are your new neighbors.

2. Object pronouns

We use them to refer to the object of a sentence without using names.

They are: **me, you, him, her, us, them** (for people);

it, them (for objects and animals)

Example: Do you know **him**? Yes, and I know **her too**. I know **them**.

Is that **you**? Yes, it's **me**; open the door please.

Summary

	Persons	**Things/Animals**
Subject Pronouns	I, you, he, she, we, they	it, they
Object Pronouns	me, you, him, her us, them	it, them

Practice

Subject pronouns

1. Who is Mr. Sung? _____ is the new music teacher.
2. Am _____ running too fast?
3. Where is the new table? _____ is in the kitchen.
4. Where is the cat? _____ is in the garden.
5. Let's eat there. _____ have great hamburgers
6. Why are _____ smiling?
7. This is Julie, _____ is a famous artist.
8. Willie is her son. _____ is a musician.
9. Mr. and Mrs. Kim are going out tonight. _____ are going to see a movie.
10. Hi Sally and Pam, where are you going. _____ are going to lunch.

Object Pronouns

1. A: Is this your picture? B: Yes, give ____ it.
2. Children running after a bus: 'Wait for _____.'
3. The door is open. Please close ____.

4. Can I help _____?
5. Please tell _____ the price of that picture.
6. He loves _____.
7. My sister is coming to visit tonight. We are meeting _____ at the bus station.
8. A: Is Mr. Baker your teacher? B: Yes, he is. I like _____ a lot.
9. Mrs. Johnson is sleeping now. Please call _____ later.
10. A: We're going to dinner with Mr. and Mrs. Fernandez.

B: Oh, great. I really like _____.

9. The Pronouns
Possessive Pronouns

- **Look at these examples carefully:**

A: Is this **your** bag? Meaning: Does this bag **belong** to you?

B: Yes, it's **mine**. Meaning: Yes, this bag **belongs** to me

'**your'** and '**mine'** are pronouns; they are possessive pronouns.

1. Possessive pronouns

1. Use

We use the Possessive pronouns to show belongings without using names.

2. Form

The possessive pronouns have two forms:

a) Adjective

Adjective pronouns are always followed by the noun they describe. They are: **my, your, his, her, its, our, their.**

Example: Is this **your** bag? ('your' is the adjective pronoun and 'bag' is the noun it describes.

b) Noun

Noun pronouns are used without the noun they describe. They are: **mine, yours, his, hers, ours, theirs.**

Example: Is it your turn? No, it's **his**. ('his' is the noun pronoun; it is not followed by a noun).

Summary

		Persons	Things/Animals
Possessive Pronouns	**Adjective**	my, your, his, her our, their	its, theirs
	Noun	mine, yours, his, hers, ours, theirs	

Personal Pronouns: Summary

Singular	**Subject**	**Object**	**Possessive**
First person	I	me	my, mine
Second person	you	you	your, yours
Third person	he, she, it (one)	him, her, it (one)	his, her, hers, its (one's)
Plural			
First person	we	us	our, ours
Second person	you	you	your, yours
Third person	they	them	their, theirs

Practice

Possessive Pronouns

11. A: Where is the manager? B: He is in _____ office.
12. Take off _____ sweater. It's hot in here.
13. Let's eat _____ dinner. It's getting cold.
14. This is my new dog. What is _____ name?
15. A: There is his car. B: Where is _____?
16. There is a car in the garage. It is _____.
17. Look at their clothing but look at our clothing. _____ is expensive but _____ is cheap.
18. Look, Betsy and Mario are washing _____ new motorcycle.
19. My sister and I bought new dresses. _____ is pink, _____ is blue.
20. The watch isn't working. _____ battery is old.

Practice (All pronouns)

1. Mrs. Baker is cooking dinner. _____ is in the kitchen.
2. ____ am sitting next to Jane. I am helping _____ because _____ is my friend.
3. Susan is a doctor. _____ is 35 years old. ____ husband is a teacher. _____ live in New York City.
4. Mr. Hunter isn't home. _____ is working now.
5. _____ classroom is big. _____ is very small.
6. Client to taxi driver: 'take _____ to the Fifth Avenue, please.'
7. Who is _____?
8. Oh, Rita, your cat is cute. What's _____ name?
9. This is your new book. Where is _____?
10. Look! They are driving in _____ new car.

II - Confusing words

Most of the no-native English speakers make confusion in many words, N. A. Burnham and F. L. Hutson they were beseiged by non-native speakers colleagues asking for help with their manuscripts, as many as five requests per week. So they prepared the following to help them.

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.

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!

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.

"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.

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. 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

1. 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 parentheses, 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 garage, is broken.

BUT! (Review the lesson of January 23.)

The lawn mower that is in the garage 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.

1.3. 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.

1.4. The general rule about punctuation is that it should be used to increase the clarity of your writing.

1.5. 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.

A. The French and American flags are red**,** white**,** and blue.

B. No**,** I didn't have time to write the paper.

C. You may take the book that is on my desk.

D. You may take the book**,** which is on my desk.

E. I don't like the subject**;** it's boring for me.

F. I don't like the subject**(,)** and I hate doing the homework.

G. The paper is written by Smith**,** Rogers**(,)** and Jones.

H. They refer to the publication by Lu**,** Chu**(,)** and Wu.

I. I shall be at the meeting from April 10**,** 1998 to 21 April 1998.

J. The year of publication**,** 1997**,** was not mentioned.

K. Wherever you may be in the future**,** our wishes go with you**,** and we are certain of your continued success in your field.

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.

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 specifing 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.

Let us assume that you have two samples that are undergoing different heat treatments to see what effect heating has on the sample's chemical reactivity. Sample A is put in the oven. Sample B 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?

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 **resonates**.
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.

Its&It's, Whose&Who's

The two most common mistakes (even by native speakers) concerning the use of the apostrope 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 posessive pronouns.

1. The computer doesn't work. **It**s 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.

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 PhD**s**. {British})

4. Referring to the labs of two people: There are many instruments in the two Ph.D.**'**s {American} laboratories. (or, the two PhD**s'** laboratories {British})

5. Our lab used to have only one SPM. Now we have two SPM**s**. The two SPM**s'** capabilities are very good. But today, the older SPM**'s** laser doesn't work.

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. 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.*

9. allow for, to make concession or provision for: *to allow for breakage.*

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**.

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. Keukle 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.

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.

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.

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.

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."
3. "We can **improve (better)** the paper by adding more data."
4. "By adding a vacuum layer we can **improve (better)** the terrible thermal insulation."
5. "The proposal lacks substance. How can we **improve (better)** it?"

6. "The research environment at Company X is stultifying. Don't work there until the conditions **improve (ameliorate)**."

Much and Many

Examples:

There are *many* people here.
You drank *many* glasses of wine last night.
You drank *too many* glasses of wine last night.
You didn't drink *many* glasses of wine last night.
You didn't drink *too many* glasses of wine last night.

There is *much* discussion about that topic.
I had *much* wine last night.
I had *too much* wine last night.
I didn't have *much* wine last night.
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...

"Yes, but please **not much** (only a little). I'm extremely sensitive to caffeine."

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?

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.

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 Ch. cards."
> "I did my Christmas cards." = "I wrote and mailed my Ch. 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**."

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.

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 recieves 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.

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.

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**?

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 **approximatel**y 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 **approximatel**y +-0.001 Hz.

7. Please show our visitor **about** Europe.

7b. Please show our visitor **around** the labs.

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

8. It's **approximately** 50cm in circumference.

9. It's 50 cm **around**.

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 predacative 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.

The first is that an adjective can be used in a predicative form, "The train is early."
Second, it can perform an attributive function, as in "the early train..."
Third, it can be premodified by "very" -- "the very early train."

And the fourth characteristic is that adjectives can 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**

III - Reading skills

Electromotive force

Part One: Reading

Read the text carefully to do the activities :

Current can only flow if it gets a “push.” This might be caused by a buildup of static electric charges, as in the case of a lightning stroke. When the charge builds up, with positive polarity (shortage of electrons) in one place and negative polarity (excess of electrons) in another place, a powerful electromotive force exists. It is often abbreviated EMF. This force is measured in units called volts.

Ordinary household electricity has an effective voltage of between 220 and 240; usually it is about 230. A car battery has an EMF of 12 volts (six volts in some older systems). The static charge that you acquire when walking on a carpet with hard-soled shoes is often several thousand volts. Before a discharge of lightning, many millions of volts exist.

An EMF of one volt, across a resistance of one ohm, will cause a current of one ampere to flow. This is a classic relationship in electricity, and is stated generally as Ohm’s Law. If the EMF is doubled, the current is doubled. If the resistance is doubled, the current is cut in half. This important law of electrical circuit behavior is covered in detail a little later in this book. It is possible to have an EMF without having any current. This is the case just before a lightning bolt occurs, and before you touch that radiator after walking on the carpet. It is also true between the two wires of an electric lamp when the switch is turned off. It is true of a dry cell when there is nothing connected to it. There is no current, but a current is possible given a conductive path between the two points. Voltage, or EMF, is sometimes called potential or potential difference for this reason.

Even a very large EMF might not drive much current through a conductor or resistance. A good example is your body after walking around on the carpet. Although the voltage seems deadly in terms of numbers (thousands), there are not that many coulombs of charge that can accumulate on an object the size of your body. Therefore in relative terms, not that many electrons flow through your finger when you touch a radiator so you don’t get a severe shock. Conversely, if there are plenty of coulombs available, a small voltage, such as 117 volts (or even less), can result in a lethal flow of current. This is why it is so dangerous to repair an electrical device with the power on. The power plant will pump an unlimited number of coulombs of charge through your body if you are foolish enough to get caught in that kind of situation.

A/ Comprehension :

1/-What causes the current to flow in the case of a lightning stroke?

2/-Can you have EMF without current? If yes, then illustrate with an example.

3/-What is the unit ofEMF?

4/-How does each of voltage and resistance affect current?

5/-Extract from the text an example of huge EMF that does not drive much current.

6/-Explain the reason behind considering repairing an electrical device with the power on a harmful act?

7/-What conditions that may lead to deadly flow of current?

8/ Find what or who the underlined words in the text refer to.

a) It (§1) b) your (§4)

B/Text Exploration :

1. Find in the text words that are closest in meaning to the following:

a) multiple (§2) = …… b) obtainable (§4) = ……

2. Give the opposites of the following words keeping the same root.

regular - active – connect

Static electricity

Part One: Reading

Read the text carefully to do the activities :

Charge carriers, particularly electrons, can build up, or become deficient, on things without flowing anywhere. You've probably experienced this when walking on a carpeted floor during the winter, or in a place where the humidity was very low. An excess or shortage of electrons is created on and in your body. You acquire a charge of static electricity. It's called "static" because it doesn't go anywhere. You don't feel this until you touch some metallic object that is connected to earth ground or to some large fixture; but then there is a discharge, accompanied by a spark that might well startle you. It is the current, during this discharge, that causes the sensation that might make you jump. If you were to become much more charged, your hair would stand on end, because every hair would repel every other. Like charges are caused either by an excess or a deficiency of electrons; they repel. The spark might jump an inch, two inches, or even six inches. Then it would more than startle you; you could get hurt. This doesn't happen with ordinary carpet and shoes, fortunately.

In the extreme, lightning occurs between clouds, and between clouds and ground in the earth's atmosphere. This spark is just a greatly magnified version of the little spark you get after shuffling around on a carpet. Until the spark occurs, there is a static charge in the clouds, between different clouds or parts of a cloud, and the ground. In Fig. 1, cloud-to-cloud (A) and cloud-to-ground (B) static buildups are shown. In the case at B, the positive charge in the earth follows along beneath the thunderstorm cloud like a shadow as the storm is blown along by the prevailing winds. The current in a lightning stroke is usually several tens of thousands, or hundreds of thousands, of amperes. But it takes place only for a fraction of a second. Still, many coulombs of charge are displaced in a single bolt of lightning.

A/ Comprehension :

1-Extract from the text an example of static electricity in daily life

2-Why does hair stick up with electricity?

3-How do you feel shocked after acquiring static electricity?

4-What is the most extreme example of electrostatic energy?

5-How long does lightning last and how powerful is it?

6-Where do lightning usually happen?

7/ Find what or who the underlined words in the text refer to.

You(§1) They(§2)

B/ Text Exploration :

1. Find in the text words that are closest in meaning to the following:

   Several base on

2. Give the opposites of the following words keeping the same root.

Charge connect like

Thermal energy

Part One: Reading

Read the text carefully to do the activities :

The solar energy systems impart low environmental impact. One of the most important benefits of such systems is that they produce a very low level of CO2 or other toxic gases or radioactive materials, unlike the ones that are produced by the non-renewable energy systems. But we are used to these traditional systems for producing our final energy forms [1]. Another important feature of the solar energy systems is that the cost of energy consists only of the construction and maintenance of the plant, as the source of energy is free and theoretically unlimited [2]. One of the major limitations of the solar energy systems is that these systems can only be installed in the areas where solar insolation is longer during the days and also available for maximum days of the year. Another important factor that makes the use of these systems is the limiting efficiency as compared to fossil fuel systems. So, a combination of the solar energy system and conventional fossil fuel system can be a suitable solution foreseen as these blends can supply continuous supply of energy in the absence of solar irradiation.

In the arena of solar energy systems, solar thermal energy has an enormous potential as they are proved in maximum of the prototypes experimented on. The predictions about this type of technology show that the efficiency of these particular systems can be increased to a significant level. Different techniques of active solar heating and solar thermal power generation are technically feasible and shown to have cost effectiveness, and some of them are commercially available. But the limitation is that these energy systems are highly

dependent on the local climatic conditions and may play a supplementary role in meeting energy demands which needs continuous operation [3]. So, certain regions of the world are privileged to have the solar thermal energy systems efficient enough to be implemented on a commercial basis.

Nowadays, people want to reduce the dependence on non-renewable energy. In this regard, many projects are running on solar thermal energy [4]. Energy produced from all the water-based solar thermal systems amounted 335 TWh in 2014, corresponding to an energy savings of 36.1 Mtoe and reduction of 116.4 million tons of CO2 [5].

China is in the leading position for solar thermal collector installation and has successfully employed for district water heating and space heating [6]. Extensive use of solar thermal energy for water heating and industrial process heating purpose are also seen in the US, Canada, and many EU countries [7]. European Solar Thermal Industry Federation estimated the installed capacity in EU countries to reach 1019 GW, and forecasted to contribute about 15% of the low temperature heat demand. The optimistic figure for 2050 is 2716 GW and that amount is roughly 47% of the overall heat demand in the EU. Solar thermal systems can provide up to 60% of households hot water demands and need very little maintenance cost over the life span. If compared to gas boiler, solar thermal systems are better options and the potential for reducing global warming and depletion of fossil fuel can be as lower as by 88% and 83%, respectively [8].

A/ Comprehension :

1 - What products are made from non-renewable resources?

2 - Where can solar energy systems be installed?

3 - What is an option for less reliability on non-renewable sources of energy?

4 - What does the use of solar thermal systems lead to?

5 - What are the reasons that make the cost of energy restricted only to the construction and maintenance of the plant?

6 - What is the major challenge faced by the solar energy industry?

7 - What do you mean by solar thermal system?

8/ Find what or who the underlined words in the text refer to

a.We (§1) b. they(§2)

B/Text Exploration :

1. Find in the text words that are closest in meaning to the following:
   a. Infleunce(§1) b.warming(§4)
2. Give the opposites of the following words keeping the same root.
   Like dependent active

Solar energy

Part One: Reading

Read the text carefully to do the activities :

Solar energy is energy that comes from the sun. Every day the sun radiates, or sends out, an enormous amount of energy. The sun radiates more energy in one second than people have used since the beginning of time.

Where does all this energy come from? It comes from within the sun itself. Like other stars, the sun is a big gas ball made up mostly of hydrogen and helium. The sun generates energy in its core in a process called nuclear fusion. During nuclear fusion, the sun's extremely high pressure and hot temperature cause hydrogen atoms to come apart and their nuclei (the central cores of the atoms) to fuse or combine. Four hydrogen nuclei fuse to become one helium atom. But the helium atom weighs less than the four nuclei that combined to form it. Some matter is lost during nuclear fusion. The lost matter is emitted into space as radiant energy.

It takes millions of years for the energy in the sun's core to make its way to the solar surface, and then just a little over eight minutes to travel the 93 million miles to earth. The solar energy travels to the earth at a speed of 186,000 miles per second, the speed of light.

Only a small portion of the energy radiated by the sun into space strikes the earth, one part in two billion. Yet this amount of energy is enormous. Every day enough energy strikes the United States to supply the nation's energy needs for one and a half years!

Where does all this energy go? About 15 percent of the sun's energy that hits the earth is reflected back into space. Another 30 percent is used to evaporate water, which, lifted into the atmosphere, produce's rain-fall. Solar energy also is absorbed by plants, the land, and the oceans. The rest could be used to supply our energy needs.

A/ Comprehension :

1. What are the main components that make up the sun?
2. What are the needed elements and conditions for the nuclear fusion of the sun?
3. Since 4 hydrogen nuclei are needed to form a single nucleus of helium, why does the helium nucleus weigh less than the 4 hydrogen nuclei combined?
4. How long does it take for the energy from within the Sun to reach its surface?
5. How much energy does the Sun deliver to Earth compared to the overall radiated solar energy?
6. How long does it take for radiated energy once it leaves the Sun to reach the Earth?
7. What happens to the missing matter in the nuclear fusion of the Sun?
8. Find what or who the underlined words in the text refer to
   It (2&) our(5&)

B/Text Exploration :

1. Find in the text words that are closest in meaning to the following:
   Arrives (1&) demands (4&)
2. Give the opposites of the following words keeping the same root.
   Like use

Scientific English as a Foreign Language
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.

How to Write a Paper

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.

A. Choose a collection of the figures and tables that represent your work. Sit down with your co-authors and discuss them. Agree on:
1. which figures and tables will be included in the paper,
2. the major points and/or conclusions of your paper, and
3. 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?

B. 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.

C. 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.

A. 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.

B. 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 .....

C. 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.

D. 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.

E. 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.....

F. Submit!

What should go into each section of a publication?

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.