

Friendly Texts: Description and Criteria

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Friendly texts contain features that facilitate comprehension. For example, compare the two expository texts below. Which one is, friendly, that is, helps you to understand the explanation?

TEXT A

Explanation of Earthquakes

The earth is made up of three layers: The surface is a crust. The continents lie on the surface surrounded by water. Next comes a layer called a mantle. Below it is a core of hot liquid iron. The hot liquid rises up towards the surface. As it does, it moves the continents. This movement is the cause of earthquakes.

TEXT B

Explanation of Earthquakes

The earth is made up of three layers: The surface is a crust. The continents lie on the surface surrounded by water. Next comes a layer called a mantle. Below it is a core of hot liquid iron. The hot liquid rises up toward the surface like bubbles in a pot simmering on a stove. As it does, it moves the continents. This movement is the cause of earthquakes.

We assume that you'll find Text B is friendlier.¹ The only difference between Text A and Text B is that Text B has the analogy "like bubbles in a pot simmering on a stove." This analogy helps you relate the movement within the earth to your prior knowledge, which you can then use to help you comprehend the cause of earthquakes.

The features of texts that make them friendly fit into five categories: (1) text organization, (2) explication of ideas, (3) conceptual density, (4) metadiscourse, and (5) instructional devices.

Text Organization

Text organization refers to the purpose and arrangement of information in the text. Friendly authors often state in the introduction to a text their purpose in writing it, their logic for the organization of chapters or major parts of the text, and how readers should read and learn from the text.

Discourse Consistency

One major feature of text organization is *discourse consistency*, that is, a uniform style of writing and presenting information. For example, to attain discourse consistency a text may use the same rhetorical devices throughout the text, such as a question followed by an answer; statement of a problem and presentation of a solution; a sequence of events related in their order of occurrence; an argument with evidence presented for

and against a point of view, followed by a summary or a conclusion; and a comparison-and-contrast pattern, which states the similarities and differences between two objects or ideas.

Cohesiveness

Another major feature of text organization is its *cohesiveness*, or the way information is tied together from sentence to sentence, paragraph to paragraph and chapter to chapter (Grimes, 1975). Any grammatical element can serve to relate one sentence to another. These elements, known as anaphora, are of four types:

1. substitutions of words, such as pronoun for a noun;
2. repetition of words, or using the same word or words again in a subsequent sentence;
3. summary of previous words; for example, after using three feminine names, such as Jean, Nancy, and Patricia, in one sentence, referring to them as *the girls*, and
4. deletion of previously stated words or ideas, such as *Stephen raised his hand and so did Beverly* (raise her hand). [The following paragraph contains all four types: Hallie and Ruth work some 45 miles from the University. *They* usually arrive late (to class). But the *girls* usually do not miss much because the instructor begins by answering students' questions which delays the formal part of the class until *Hallie and Ruth* arrive. *Both of them* appreciate the delay (of the class).

Conjunctions, such as *and*, *but*, *therefore*, also interrelate not only sentences, but larger units of discourse, such as paragraphs, unlike anaphora, they also provide ideational cues for the reader. For example, *and* indicates the *addition* of another idea or object, *but* implies subtraction, *as* "all *but* Douglas had a turn," *therefore* implies a logical consequence to a sequence of events or signals the reader that a conclusion to an argument is about to be presented.

Rhetorical devices, such as problem-solution, question-and-answer, and cause-and-effect patterns can operate within paragraphs and can tie together even larger sections of texts. Reviews of previous sections of text, frequently occurring as summaries at the end of a chapter or beginning of the next chapter, are a type of repetition that ties the chapters of a text together.

Explication of Information

Explication of information means to state facts or relationships directly, instead of requiring the reader to infer, organize, or construct relationships. For example, a high school history text described the French, English, Russian, and American revolutions, but did not state what they had in common or give any explanation of the conditions under which revolutions occur. In short, the text provided only descriptions of the four revolutions. Another example is a biology text that states the differences between arteries and veins, but does not explain why they differ (Bransford, 1984).

The usual rule in text-writing is to define new terms as they are introduced. They should, of course, be defined by words that are familiar to the student. The terms should also be listed in a glossary.

Prior Knowledge

Texts can be more comprehensible if they provide necessary background knowledge or show students how new ideas in the text are related to knowledge students already have. Some texts achieve this purpose by introductions that contain familiar examples. Another way to relate new knowledge to prior knowledge is through the use of analogies or figurative language.

Organizational Basis

Underlying many texts is some organizing theory or explanation. For example, high school chemistry texts can take three different approaches to chemistry: descriptive, principles, or theoretical. College texts also may be based upon a particular viewpoint. For example, Samuelson's leading text is based on Keynesian economics, and Bijou and Baer's *Child Development* is based on Skinner's reinforcement theory of learning. If a theory-based text explicates its underlying theory, readers would be able to use it to organize and retain better the multitude of applications and interpretations presented in the text.

Whether students should read and remember the text at a theory level or only at a descriptive level is a decision the instructor of a course should make. Some authors help their readers by pointing out their text can be approached from either or both levels of comprehension.

Conceptual Density

Conceptual density refers to the number of new ideas and vocabulary that are contained in the text. Some high school texts may have as many as 400 technical words in their glossary. This is due in part to an effort to be comprehensive, perhaps to satisfy content guidelines and economic criteria for adoption of texts, and in part because of the knowledge explosion, particularly in technical fields. As a result, high school texts have become burdensome. Writers can help readers comprehend these texts by spacing out the presentation of information. They can do so by following the rules of good paragraph writing: introduce a main idea, clarify it, and give several examples. Texts written this way will be clearer, but longer than terse texts that in essence may state only one main idea or generalization after another, as you would find in a summary of a text. The latter may be understood by instructors, who can generate their own clarifications and examples, but not by students, who need the wordier text to bridge the gap between their own knowledge and experience and the new knowledge in the text (Pepper, 1981). A possible remedy would be the adoption of a sequence of several texts for a year-long course instead of only one.

Metadiscourse

Metadiscourse literally means that the author is talking directly to the reader about the information in the text. The author might point out the purpose or goal of the text, indicate what information is essential for achieving it, advise readers on how to learn from the text, and show readers how to apply information gained from the text to other situations (Camiciottoli, 2003). Knowing some readers may have a limited background, the author might provide this information, much as a teacher might add clarifying information or comments to a text.

In general, metadiscourse is like a conversation between the author and the reader about the text (Crismore, Markkanen, & Steffensen, 1993). It may take the form of an I-You dialogue. For instance, you will find that texts and even scientific reports are getting away from the third person, passive tense that omits the agent for the action. Instead of saying, "It was found that something occurred" you are more likely to find, "I found that . . ." or "Stephen discovered that. . ."

Instructional Devices

Instructional devices are those features of a text that aid the reader to comprehend the text. A table of contents indicates the text's sequence of ideas. Other organizational aids are headings and subheadings. Since knowledge of vocabulary is the best predictor of comprehension, a glossary facilitates achievement of this goal. The terms in the glossary should also be presented in bold faced type and defined in the text as they occur. Another helpful feature is an index that groups related ideas in the text.

Authors also reveal to readers where the text is going by providing an overview, either in verbal or graphic terms. Use of questions at the beginning of chapters arouse students' curiosity and focus attention on essential information. Friendly texts use diagrams, tables, and graphs that enable readers to perceive relationships among ideas, objects, or numerical data. Authors of friendly texts annotate their own text, sometimes printing information in the margin (usually background knowledge), but more often this information is written right into the text.

Summaries and conclusions indicate the essential information in the text; problems or questions at the end of chapters help students test their understanding of this information. But sometimes the questions or problems may not be relevant or may be too easy or difficult to help the readers. Since transfer, ability to apply knowledge gained to new situations, is a major purpose in learning, friendly texts will facilitate it by providing suggestions for application of the text's knowledge to new situations.

These features of a friendly text are restated at the end of this article in a list of criteria for selecting friendly texts. Although some text features play a more important role than others in facilitating comprehension, we have given one point to each feature because we have no basis for any differential weighing. Nor have we any criterion for stating when a text shifts from the unfriendly to the friendly end of the continuum. We can only say that a text with more of these features is more likely to facilitate comprehension than a text with fewer features.

But we do know that whether a text is or is not friendly depends not only on the features within the text, but also on its position within a curriculum and the role that a teacher plays in using the text, particularly how the teacher adapts the text to individual differences among students in a class. Finally, comprehension of a text depends upon an interaction between the information in the text and the resources the reader can mobilize in response to the task-demands of the text, as well as his or her purpose in reading the text (Bean 2002). We shall clarify each of these extra-text determinants of comprehension.

Determinants of Comprehension Outside the Text

Curriculum Consideration

In evaluating a text, we presume it is consistent with a sequence of instruction and fits into the next step in the student's knowledge development. In short, a text should start at a knowledge level that the student has already attained and take the student systematically on to a higher and more abstract stage in the acquisition of knowledge, including knowledge of concepts, events, and contexts. Moreover, we presuppose that the prior curriculum has been sequential and hierarchically organized. We also assume that students have progressed through this curriculum and have acquired the content, processes, and skills taught in it.

Consequently, their background knowledge and ability to learn from text has been adequately developed by prior school levels; the students are therefore ready for a higher level of development. If these conditions are met, then we can determine whether a text has the necessary characteristics of facilitate the student's next stage of development. Whether the facilitation is realized also depends upon the teacher.

Teacher's Role

A teacher plays a role in all aspects of learning in a classroom setting, among which are showing students how to learn in the particular content area and from the text, designing materials to aid students' ability to learn from text (Bean, Readence, & Baldwin, (2007), motivating students by explaining the relevance of the course to their knowledge development and to applications in everyday life, explicating and clarifying the text, relating text information to the students' prior knowledge, providing a context for comprehending the text, assigning tasks that help students use and therefore retain information presented in lectures and in the text, providing relevant tests at appropriate points in the course so that students can gain knowledge of their progress and information on their strengths and weaknesses. Indeed, a teacher can make friendly and unfriendly texts more comprehensible to students.

Briefly summarized, coherence among all four components of a classroom (students, text, test, and teacher) enhance achievement (Singer, 1982). Ecological factors, conditions inside and outside the classroom that students are experiencing, also affect their performance in the classroom (Bean (2002).

Individual Differences

Although a text may be appropriate and friendly to a particular reader, it is not likely to fit an entire class of students. Any heterogeneous class varies greatly in its ability to learn from text, whether the class is at the first grade or at the college level. The range in achievement at the first grade is four years, but gradually expands until at the twelfth grade it is 12 years. Hence, a friendly text can at best fit only students at a particular level of development. The teacher's task is to adopt instructional strategies that will enable all students within the class to successfully interact with a text and thus learn from it. Single and multiple text strategies that teachers can use for helping students learn from text can be found in textbooks such as *Content Area Literacy: An Integrated Approach* (2007).

Interaction between Text Information and Reader Resources

Comprehension does not depend upon the text alone. Comprehension is the construction of meaning that results from an interaction between features of the text and the reader's resources (Rumelhart, 1976; Singer, 1983), in accordance with the perspective and purposes of the reader (Bean (2002)). The features of the text activate the relevant resources a reader can command for constructing meaning for the text. For example, the text's metadiscourse can lead a reader to select a particular goal and adopt a particular perspective and purpose for responding to the text. Reader resources are the reader's prior knowledge, abilities, purposes, perspectives, interests, attitudes, values, and feelings.

Readability Formulas

Readability formulas, such as Fry's graph (Fry, 1977) for estimating readability shown at the end of this article, usually consist of two factors: sentence length and word difficulty. Sentence length is an index of syntactic complexity while word difficulty is an estimate of the semantic level of a text. These two criteria subsume some textual organization and conceptual density features, but these criteria ignore the teaching features of explication, metadiscourse, and instructional devices, as well as the extra text determinants of text-reader interactions and the teacher's role in compensating for unfriendly text features.

Readability estimations are somewhat useful for placing texts at a given point in a graded curriculum, even though the standard error of any readability formula is plus or minus about 1.5 grade levels. For example, a readability level of 4.7 really represents a readability range that can vary from 3.2 to 6.2. In short, a readability level is only a gross indicator of a text's difficulty.

Although readability estimates are useful for placing a text within a graded curriculum, they do not specify the specific features that make one text friendlier than another, nor do they indicate the interactions between the text, the teacher, and the reader. Hence, determination of a text's readability level is only a first step in estimating a text's friendliness. The next step is to evaluate the friendliness of specific features of a text. Finally, if a prediction is to be made on how well students in a classroom situation are likely to comprehend a text, then a third step is to determine how a particular teacher is likely to enhance the friendliness of a text, the readers' resources, and the interactions between the text and the reader. However, we now only have scales for estimating the first two steps; we need another scale, a teacher-text-reader enhancement scale before we can act on the third step. In the meantime, we can carry out the first two steps by (1) using the Fry graph to estimate readability level and (2) the Friendly Text Evaluation Scale to determine the comprehension facilitation of a text.

A recent study demonstrates the value of applying the Singer Friendly Text Inventory to our own scholarly writing. Schumm, Konopak, Readence, and Baldwin (1989) examined 32 research articles from the reading field. They found that these authors could improve the "friendliness" of their writing by avoiding long, ponderous sentences and unnecessary jargon.

Summary and Conclusion

We have presented criteria for determining the friendliness of a text. But we have also pointed out that a friendly text presupposes a reader with the necessary resources for interacting with and constructing meaning for the text, a curriculum that has adequately developed these resources, a teacher who can favorably influence the interaction between readers and the text and whose tests provide appropriate and timely feedback on the results of this interaction, and an environment that is conducive to learning from text. If these presuppositions are valid, then it is possible to use the following evaluation scale to determine a text's friendliness.

Friendly Text Evaluation Scale

Directions: Read each criterion and judge the degree of agreement or disagreement between it and the text. Then circle the number to the right of the criterion that indicates your judgment.

1. SA - Strongly
2. A - Agree
3. U - Uncertain
4. D - Disagree
5. SD - Strongly Disagree

I. Organization

	SA	A	U	D	SD
1. The introduction to the book and each chapter explain their purposes.	1	2	3	4	5
2. The introduction provides information on the sequence of the texts contents.	1	2	3	4	5
3. The introduction communicates how the reader should learn from the text.	1	2	3	4	5
4. The ideas presented in the text follow a unidirectional sequence. One idea leads to the next.	1	2	3	4	5
5. The type of paragraph structure organizes information to facilitate memory. For example, objects and there properties are grouped together so as to emphasize relationships.	1	2	3	4	5
6. Ideas are hierarchically structured either verbally or graphically.	1	2	3	4	5
7. The author provides cues to the way information will be presented. For example the author states: "There are five points to consider."	1	2	3	4	5
8. Signal words (conjunctions, adverbs) and rhetorical devices (problem-solution, question-answer, cause-effect, comparison and contrast, argument-proof) interrelate sentences, paragraphs, and larger units of discourse.	1	2	3	4	5

Discourse Consistency

9. The style of writing is consistent and coherent. For example the paragraphs, sections, and chapters build to a conclusion. Or they begin with a general statement and then present supporting ideas. Or the text has a combination of these patterns. Any one of these patterns would fit this consistency criterion
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

Cohesiveness

10. The text is cohesive. That is, the author ties ideas together from sentence to sentence, paragraph to paragraph, chapter to chapter.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

II. Explication

11. Some texts may be read at more than one level, e.g., descriptive vs. theoretical. The text orients students to a level that is appropriate for the students.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
12. The text provides reasons for functions or events. For example, the text, if it is a biology text, not only lists the differences between arteries and veins, but also explains why they are different.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
13. The text highlights or italicizes and defines new terms as they are introduced at a level that is familiar to the student.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
14. The text provides necessary background knowledge. For example, the text introduces new ideas by reviewing or reminding readers of previously acquired knowledge or concepts.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
15. The author uses examples, analogies, metaphors, similies, personifications, or allusions that clarify new ideas and makes them vivid.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
16. The author explains ideas in relatively short active sentences.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
17. The explanations or theories that underlie the text are made explicit. E.g. Keynesian theory in Samuelson's economic text. Skinner's theory in Bijou and Baer's *Child Development*; behavioristic or gestalt theories in psychology texts.
- | | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|

III. Conceptual Density

- | | | | | | | |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 18. | Ideas are introduced, defined or clarified, integrated with semantically related ideas previously presented in the text, and examples given before additional ideas are presented. | 1 | 2 | 3 | 4 | 5 |
| 19. | The vocabulary load is appropriate. For example, usually only one new vocabulary item per paragraph occurs throughout the text. | 1 | 2 | 3 | 4 | 5 |
| 20. | Content is accurate, up-to-date, and not biased | 1 | 2 | 3 | 4 | 5 |

IV. Metadiscourse

- | | | | | | | |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 21. | The author talks directly to the reader to explain how to learn from the text.
For example, the author states that some information in the text is more important than other information. | 1 | 2 | 3 | 4 | 5 |
| 22. | The author establishes a purpose or goal for the text. | 1 | 2 | 3 | 4 | 5 |
| 23. | The text supplies collateral information for putting events into context. | 1 | 2 | 3 | 4 | 5 |
| 24. | The text points out relationships to ideas previously presented in the text or to the reader's prior knowledge. | 1 | 2 | 3 | 4 | 5 |

V. Instructional Devices

- | | | | | | | |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 25. | The text contains a logically organized table of contents. | 1 | 2 | 3 | 4 | 5 |
| 26. | The text has a glossary that defines technical terms in understandable language. | 1 | 2 | 3 | 4 | 5 |
| 27. | The index integrates concepts dispersed throughout the text. | 1 | 2 | 3 | 4 | 5 |
| 28. | There are overviews, proposed questions, or graphic devices, such as diagrams, tables, and graphs throughout the text that emphasize what is to be learned in the chapters or sections. | 1 | 2 | 3 | 4 | 5 |
| 29. | The text includes marginal annotations or footnotes that instruct the reader. | 1 | 2 | 3 | 4 | 5 |
| 30. | The text contains chapter summaries that reflect its main points. | 1 | 2 | 3 | 4 | 5 |

31.	The text has problems or questions at the literal, interpretive, applied, and evaluative levels at the end of each chapter that help the reader understand knowledge presented in the text.	1	2	3	4	5
32.	The text contains headings and subheadings that divide the text into categories that enable readers to perceive the major ideas.	1	2	3	4	5
33.	The author provides information in the text or at the end of the chapters or the text that enable the reader to apply the knowledge in the text to new situations.	1	2	3	4	5
34.	The author used personal pronouns that makes the text more interesting to the reader.	1	2	3	4	5

TOTAL_____

Score

Add the numbers circled.

Score range: 34 – 170 points

Interpretation of scores:

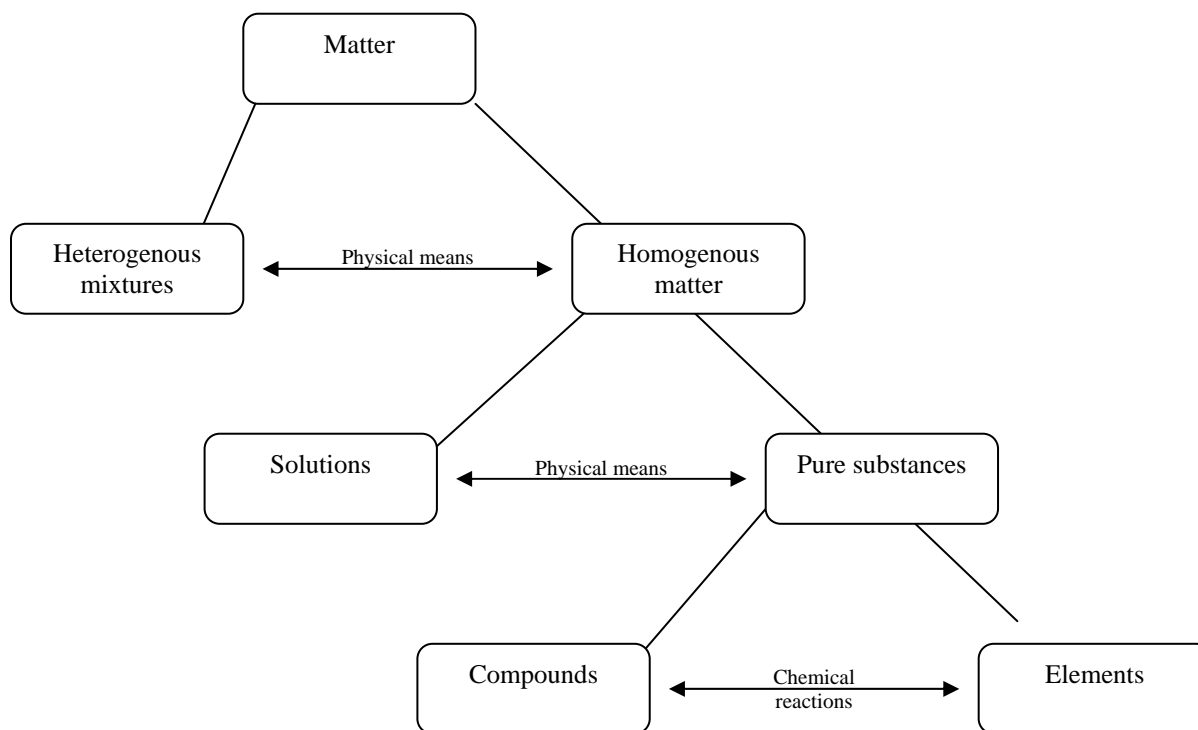
A score closer to 34 implies the text is friendly; scores closer to 170 suggest the text is unfriendly.

Examples

We have selected examples to illustrate some of our criteria. Space limitations preclude us from providing examples for each of them. However, some criteria are self-evident, particularly those listed under *instructional devices*. We have tried to formulate all of our criteria so that they can be readily applied. But some of them need to be clarified through the use of examples. The examples we have chosen come from freshmen college texts in chemistry and calculus. The chemistry texts are not equivalent: the friendly text is the main text for the course and the less friendly text is a laboratory manual for the introductory course.

Texts are not uniformly friendly or unfriendly. Indeed, our examples for friendly vs. unfriendly texts cross over for our two calculus texts. However, one of the calculus texts overall was friendlier than the other.

Friendly text



The classification of matter.

Any portion of matter that is uniform throughout is said to be *homogeneous*. Homogeneous mixtures are known as solutions. For example, when salt and water are mixed, a homogeneous mixture, or solution, forms. The salt is said to dissolve in the water. Mixtures that are not homogeneous are said to be *heterogeneous*. When water and clay are mixed, no solution forms; the resultant mixture is heterogeneous. A heterogeneous mixture can generally be separated by some physical means into homogeneous components¹

Unfriendly text

The fact that different substances have different solubilities in a given solvent can be used in several ways to effect a separation of substances from mixtures in which they are present. We have seen in a previous experiment how fractional crystallization allows us to obtain pure substances by relatively simple procedures based on solubility properties. Another widely used resolution technique, which also depends on solubility differences, is chromatography.²

Example 1. Illustration of criterion 26: Use of a diagram to represent hierarchically structured ideas.

1. Theodore L. Brown, and H. Eugene LeMay, Jr., *Chemistry: The Central Science*, 2nd Ed. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1981).

2. Emil J. Slowinski, Wayne C. Wolsey, and William L. Masterton, *Chemical Principles in the Laboratory with Qualitative Analysis* (Philadelphia, PA: W. B. Saunders, 1978).

Friendly text

PERIODIC TRENDS.

Much of the material in this chapter will be much clearer and easier to remember if you keep in mind several trends in physical and chemical properties that can be related to position in the periodic table. Some of the more important of these are illustrated in Figure 21.3. Recall that electronegativity increases as we move up in a given family, and increases from left to right across the table. As a result nonmetals have higher electronegativities than do metals. The tendency toward metallic character increases as we move downward in each group.¹

Unfriendly text

Most solid chemical compounds will contain some water if they have been exposed to the atmosphere for any length of time. In most cases the water is present in quite small amounts and is merely absorbed on the surface of the crystals. This absorbed water can usually be removed by gentle heating. Other solid compounds will contain larger amounts of water that are bound to the compound more strongly. These compounds are usually ionic salts. The water present in these salts, called water of hydration, is generally bound to the cations in the compound.²

Example 2. Illustrations of criterion 19: Metadiscourse occurs throughout the text represented by the passage at the top. No metadiscourse occurs in the second text. The lower passage is a typical introductory passage for the second text. Note that it does not contain any metadiscourse.

Friendly text

SUMMARY

Our major concern in this chapter has been the relationship between electron configurations and the properties of atoms, especially as organized by the periodic table. We saw that the electron configurations of many-electron atoms can be written by placing electrons into orbitals in the following order:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, . . .

Subshells with a given principal quantum number, such as the 3s, 3p, and 3d subshells, do not have the same energies. This fact can be understood in terms of the screening effect and the average distance of an electron in each of these subshells from the nucleus.

The Pauli exclusion principle places a limit of two on the number of electrons that may occupy any one atomic orbital. These two electrons differ in their electron-spin quantum number, m_s .¹

Unfriendly text

LEARNING GOALS

Having read and studied this chapter, you should be able to:

1. List the factors that determine the energy of an electron in a manyelectron atom. You should be able to explain the fact that electrons with the same value of principal quantum number (n) but differing values of the azimuthal quantum number (l) possess different energies.
2. Explain the concepts of effective nuclear charge and the screening effect as they relate to the energies of electrons in atoms.
3. State the Pauli exclusion principle and Hund's rule and illustrate how they are used in writing the electronic structures for the elements.²

Example 3. Illustration of criterion 28: The first text, as shown above, used the instructional device of chapter summaries to emphasize the significant information presented in the chapter. The second text did not have any chapter summaries, even though the experiment could have been summarized.

Both texts had these instructional devices; table of contents diagrams to illustrate objects, and problems at the end of the chapter.

1. Theodore L. Brown, and H. Eugene LeMay, Jr., *Chemistry: The Central Science*, 2nd Ed. (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1981).

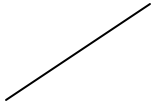

2. Emil J. Slowinski, Wayne C. Wolsey, and William L. Masterton, *Chemical Principles in the Laboratory with Qualitative Analysis* (Philadelphia, PA: W. B. Saunders, 1978).

Friendly text

WHAT IS CALCULUS?

To a Roman in the days of the empire a “calculus” was a little pebble used in counting and in gambling. Centuries later the verb “calulare” came to mean “to compute,” “to reckon,” “to figure out.” To the engineer and mathematician of today calculus is the branch of mathematics that takes in elementary algebra and geometry and adds one more ingredient: *the limit process*.

Calculus begins where elementary mathematics leaves off. It takes ideas from elementary mathematics and extends them to a much more general situation. Here are some examples. On the left-hand side you will find an idea from elementary mathematics: on the right, this same idea as enriched by calculus.¹

Elementary Mathematics	Calculus
 <p>slope of a line $y = m x + b$</p>	 <p>slope of a curve $y = f(x)$</p>

Unfriendly text

Calculus is the mathematical tool used to analyze changes in physical quantities. It was developed in the seventeenth century to study four major classes of scientific and mathematical problems of the time:

1. Find the tangent to a curve at a point.
2. Find the length of a curve, the area of a region, and the volume of a solid.
3. Find the maximum or minimum value of a quantity—for example, the maximum and minimum distances of a planet from the sun, or the maximum range attainable for a projectile by varying its angle of fire.
4. Given a formula for the distance traveled by a body in any specified amount of time, find the velocity and acceleration of the body at any instant. Conversely, given a formula that specifies the acceleration or velocity at any instant, find the distance traveled by the body in a specified period of time.

These problems were attacked by the greatest minds of the seventeenth century, culminating in the crowning achievements of Gottfried Wilhelm Leibniz and Isaac Newton—the creation of calculus.²

Example 4. Criterion 20: Defining purposes and terms. Note: More friendly text also concretizes information.

1. S. L. Sales and Einar Hill, *Calculus: One and Several Variables. Part I*. 3rd Ed. (New York: Wiley, 1978). p. 1.
2. Anton Howard, *Calculus with Analytic Geometry: Brief Edition* (New York: Wiley, 1981), p. xxi.

Friendly text

LIMITS (AN INTUITIVE INTRODUCTION)

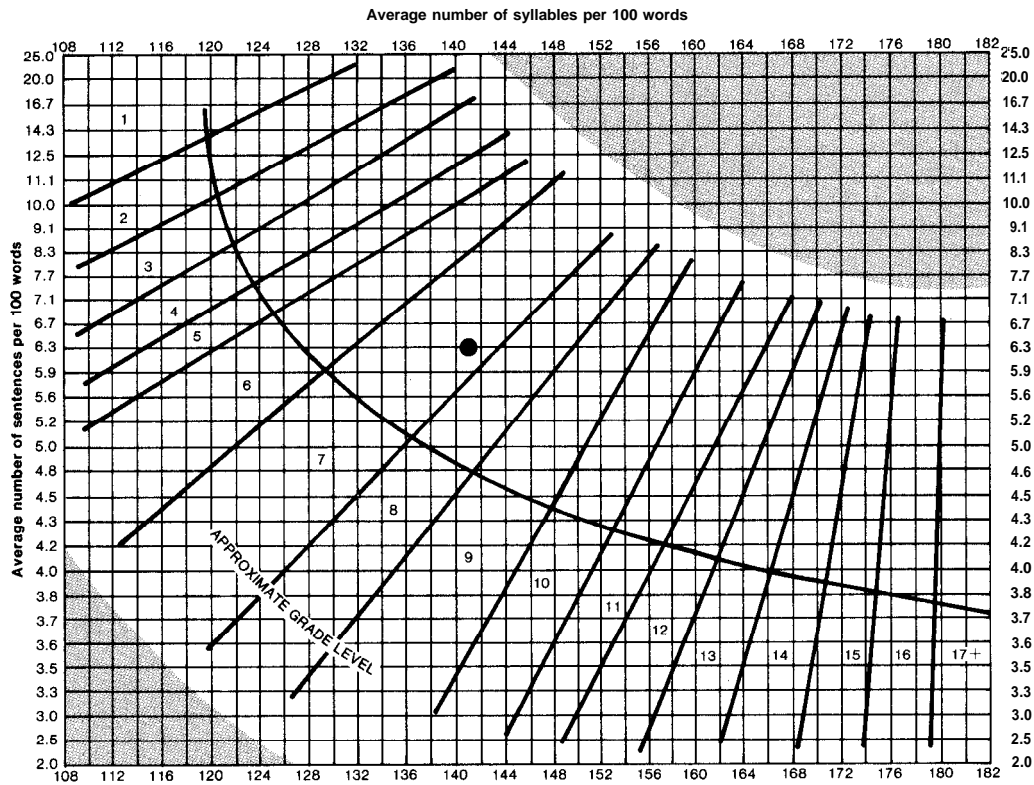
In the last section we saw that the concepts of tangent and instantaneous velocity ultimately rest on the notion of a “limit” of “value approached by” a function. In this section as well as the next few we will investigate the notion of limit in more detail. Our development of limits in this text proceeds in three stages:

1. First we discuss limits intuitively.
2. Then we discuss methods for computing limits.
3. Finally, we give a precise mathematical discussion of limits.¹

Example 5. Illustration of criterion 26: Friendly text provides an overview of the section. Also note: The text relates prior to new knowledge.

1. Howard Anton, *Calculus with Analytic Geometry: Brief Edition* (New York: John Wiley, 1981), p. 85.

GRAPH FOR ESTIMATING READABILITY-EXTENDED
 by Edward Fry, Rutgers University Reading Center, New Brunswick, N.J. 08904



Directions: Randomly select 3 one hundred word passages from a book or an article. Plot average number of syllables and average number of sentences per 100 words on graph to determine the grade level of the material. Choose more passages per book if great variability is observed and conclude that the book has uneven readability. Few books will fall in gray area but when they do grade level scores are invalid.

Count proper nouns, numerals and initializations as words. Count a syllable for each symbol. For example, "1945" is 1 word and 4 syllables and "IRA" is 1 word and 3 syllables.

EXAMPLE:	SYLLABLES	SENTENCES
1st Hundred Words	124	6.6
2nd Hundred Words	141	5.5
3rd Hundred Words	158	6.6
AVERAGE	141	6.3

READABILITY 7th GRADE (see dot plotted on graph)

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For further information and validity data see the *Journal of Reading* December, 1977.

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