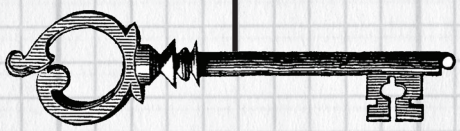
INTRODUCTORY LOGIC

The Fundamentals of Thinking Well

TEACHER: FIFTH EDITION

Canon Logic Series



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A NOTE to the TEACHER for the FIFTH EDITION

Logic is the science and art of reasoning well. We reason as we draw conclusions from other information by means of logical arguments. Arguments are made up of premises and conclusions, which are types of statements. Statements are sentences that are true or false. Categorical statements predicate something of a subject, and thus connect subject and predicate terms. A term is the verbal expression of a concept. Consequently, in order to follow logical arguments as we reason, we must know how to determine the truth of statements, and to understand statements, we need to be able to define the terms that make up those statements.

In this text we begin with terms. Your students will learn how to define terms and how to relate terms to other terms in genus and species charts. They will then study statements, discovering ways to determine the truth of a given statement, and will examine how statements relate to each other. Next, they will learn how to put statements together into arguments, and gather strategies for distinguishing valid arguments from invalid ones. They will do this first in the tightly controlled, artificial environment of categorical syllogisms. You will then lead them into the real world as they take the tools they have mastered and learn how to apply them to arguments in normal English. Once they have gained the skills of analyzing the arguments of others, they will take a brief foray into constructing arguments to establish conclusions of their own. They will then finish this course by learning to detect the fallacies that litter arguments in daily life.

This logic course thus follows the program outlined by Dorothy Sayers in "The Lost Tools of Learning." In that seminal essay, she outlined for us the course of study for the medieval logic student, who learned "how to use language: how to define his terms and make accurate statements; how to construct an argument and how to detect fallacies in argument." Terms, statements, arguments, fallacies—these are concepts that will become familiar to your students in this study of *Introductory Logic: The Fundamentals of Thinking Well*.

April 2014

SCHEDULES

It's up to you to choose the pace for working through *Introductory Logic*. If you're comfortable with moving at a quick pace, and can schedule three to five classes per week, you can work through the course in one semester. Those who prefer a more leisurely pace can plan to complete the course in a year with one to three class meetings per week. On the following two pages, we have provided two sample schedules. The first option is based on meeting daily for one semester. The second option fits a schedule of three weekly classes for a whole year. Use these as a guideline, and adapt as needed to meet the needs of your class or homeschool. Just cover the material listed for each week in as many days as you have per week, and you'll finish on time. Or alter either schedule to suit your students' pace and the time you have allotted for the course: add or subtract weeks and adjust the pacing of the material accordingly to fit your needs.

PAGE NUMBERS

This Teacher text contains the entire Student version as well, with the same page numbers. The Arabic numerals (on single-columned pages) are the same in both texts. Your teacher notes (double-columned pages) are numbered with Roman numerals.

DAILY LESSON PLANS

Each student lesson in the Teacher edition is accompanied by double-columned teaching notes: objectives, step-by-step teaching instructions, assignments, and more. You can decide whether you want to read through the lesson with the students out loud, have the students read through it alone and then teach through it, teach through it without reading it…whatever suits your personal teaching style best.

GRADING

This Teacher Edition contains all the answers you need for all exercises, quizzes, and tests. For many lessons, answers may vary depending on the imagination and creativity of your students. Expect this; you'll still be able to grade the differing answers fairly if you, as teacher, thoroughly understand the principles involved. We've included point values for each quiz or exercise question to help with this. Consider giving partial credit for incorrect answers that have a piece of the final answer right. If you mark an answer wrong, but a student thinks it is *not* wrong, consider allowing them to try to argue the point back, in writing. This gives them practice arguing, and they just might be right.

DVD COURSE

If you can take advantage of the fantastic DVD course companion, we'd suggest that you watch the day's lesson first (let our teacher's years of classroom experience do the hard work), and then you can answer any questions as your students work on the exercises. The DVD works through every "Form B" Test, so that can be especially helpful for practice tests.

As always, if you've got questions, ideas, or just want to get in touch, call 208-892-8074 or find us online at www.canonpress.com. We'd love to help you as you teach the fundamentals of thinking well.

SCHEDULE OPTION 1: ONE SEMESTER

This schedule will allow you to cover the contents of *Introductory Logic* meeting daily over the course of a sixteen-week semester. Adjust daily or weekly assignments as needed.

Week	Day	Text	Assignment
1	Mon	Introduction	
	Tues	Lesson 1	Exercise 1
	Wed	Lesson 2	Exercise 2
	Thur	Lesson 3	Exercise 3
	Fri	Quiz Day	*Quiz One*
2	Mon	Lesson 4	Exercise 4
	Tues	Lesson 5	Exercise 5
	Wed	Quiz Day	*Quiz Two*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test One*
3	Mon	Lesson 6	Exercise 6
	Tues	Lesson 7	Exercise 7
	Wed	Lesson 8	Exercise 8
	Thur	Quiz Day	*Quiz Three*
	Fri	Lesson 9	Exercise 9
4	Mon	Lesson 10	Exercise 10
	Tues	Lesson 11	Exercise 11
	Wed	Quiz Day	*Quiz Four*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Two*
5	Mon	Lesson 12	Exercise 12
	Tues	Lesson 13	Exercise 13
	Wed	Lesson 14	Exercise 14
	Thur	Quiz Day	*Quiz Five*
	Fri	Lessons 15 & 16	Exercise 15
6	Mon	Lesson 17	Exercise 16
	Tues	Lesson 18	Exercise 17
	Wed	Quiz Day	*Quiz Six*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Three*
7	Mon	Lesson 19	Exercise 18
	Tues	Lesson 20	Exercise 19:1-5
	Wed	Lesson 20	Exercise 19:6-10
	Thur	Quiz Day	*Quiz Seven*
	Fri	Lesson 21	
8	Mon	Lesson 22	Exercise 20
	Tues	Lesson 23	Exercise 21
	Wed	Quiz Day	*Quiz Eight*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Four*
9	Mon	Lesson 24	Exercise 22
	Tues	Challenge Project	Exercise 22
	Wed	Challenge Project	Exercise 22
	Thur	Quiz Day	*Quiz Nine*
	Fri	Lesson 25	Exercise 23
10	Mon	Lesson 26	Exercise 24
	Tues	Lesson 26	Exercise 25
	Wed	Quiz Day	*Quiz Ten*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Five*
11	Mon	Lesson 27	Exercise 26
	Tues	Lesson 27	Exercise 27:1-3
	Wed	Lesson 27	Exercise 27:4-6
	Thur	Quiz Day	*Quiz Eleven*
	Fri	Lesson 28	Exercise 28
12	Mon	Lesson 29	Exercise 29
	Tues	Lesson 29	Exercise 30
	Wed	Quiz Day	*Quiz Twelve*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Six*
13	Mon	Lesson 30	Exercise 31
	Tues	Lesson 30	Exercise 32
	Wed	Quiz Day	*Quiz Thirteen*
	Thur	Lesson 31	Exercise 33
	Fri	Lesson 31	Exercise 34
14	Mon	Lesson 32	Exercise 35:1-5
	Tues	Lesson 32	Exercise 35:6-10
	Wed	Quiz Day	*Quiz Fourteen*
	Thur	Review for Test	Review Questions
	Fri	Test Day	*Test Seven*
15	Mon	Lesson 33	Exercise 36
	Tues	Lesson 34	Exercise 37
	Wed	Lesson 35	Exercise 38
	Thur	Quiz Day	*Quiz Fifteen*
	Fri	Lesson 36	Exercise 39
16	Mon	Review for Test	Review Questions
	Tues	Test Day	*Test Eight*
	Wed	Review for Comprehensive Exam	
	Thur	Review for Comprehensive Exam	
	Fri	Exam	*Comprehensive Exam*

SCHEDULE OPTION 2: FULL YEAR

This schedule will allow you to cover the contents of *Introductory Logic* meeting three days per week over the course of a thirty-two-week school year. Adjust as needed if you meet fewer days per week.

Week	Day	Text	Assignment
1	1	Introduction	
	2	Lesson 1	Exercise 1
	3	Lesson 2	Exercise 2
2	4	Lesson 3	Exercise 3
	5	Finish Exercises and Review	
	6	Quiz Day	*Quiz One*
3	7	Lesson 4	Exercise 4
	8	Lesson 5	Exercise 5
	9	Quiz Day	*Quiz Two*
4	10	Review for Test	Review Questions
	11	Practice Test	*Test 1a*
	12	Test	*Test 1b*
5	13	Lesson 6	Exercise 6
	14	Lesson 7	Exercise 7
	15	Lesson 8	Exercise 8
6	16	Finish Exercises and Review	
	17	Quiz Day	*Quiz Three*
	18	Lesson 9	Exercise 9
7	19	Lesson 10	Exercise 10
	20	Lesson 11	Exercise 11
	21	Quiz Day	*Quiz Four*
8	22	Review for Test	Review Questions
	23	Practice Test	*Test 2a*
	24	Test Day	*Test 2b*
9	25	Lesson 12	Exercise 12
	26	Lesson 13	Exercise 13
	27	Lesson 14	Exercise 14
10	28	Finish Exercises and Review	
	29	Quiz Day	*Quiz Five*
	30	Lesson 15, 16	Exercise 15
11	31	Lesson 17	Exercise 16
	32	Lesson 18	Exercise 17
	33	Quiz Day	*Quiz Six*
12	34	Review for Test	Review Questions
	35	Practice Test	*Test 3a*
	36	Test Day	*Test 3b*
13	37	Lesson 19	Exercise 18
	38	Lesson 20	Exercise 19:1-5
	39	Lesson 20	Exercise 19:6-10
14	40	Finish Exercises and Review	
	41	Quiz Day	*Quiz Seven*
	42	Lesson 21	
15	43	Lesson 22	Exercise 20
	44	Lesson 23	Exercise 21
	45	Quiz Day	*Quiz Eight*
16	46	Review for Test	Review Questions
	47	Practice Test	*Test 4a*
	48	Test Day	*Test 4b*
17	49	Lesson 24	Exercise 22
	50	Challenge Project	Exercise 22
	51	Challenge Project	Exercise 22
18	52	Finish Project and Review	
	53	Quiz Day	*Quiz Nine*
	54	Lesson 25	Exercise 23
19	55	Lesson 26	Exercise 24
	56	Lesson 26	Exercise 25
	57	Quiz Day	*Quiz Ten*
20	58	Review for Test	Review Questions
	59	Practice Test	*Test 5a*
	60	Test Day	*Test 5b*
21	61	Lesson 27	Exercise 26
	62	Lesson 27	Exercise 27:1-3
	63	Lesson 27	Exercise 27:4-6
22	64	Finish Exercises and Review	
	65	Quiz Day	*Quiz Eleven*
	66	Lesson 28	Exercise 28
23	67	Lesson 29	Exercise 29
	68	Lesson 29	Exercise 30
	69	Quiz Day	*Quiz Twelve*
24	70	Review for Test	Review Questions
	71	Practice Test	*Test 6a*
	72	Test Day	*Test 6b*
25	73	Lesson 30	Exercise 31
	74	Lesson 30	Exercise 32
	75	Quiz Day	*Quiz Thirteen*
26	76	Lesson 31	Exercise 33
	77	Lesson 31	Exercise 34
	78	Finish exercises	
27	79	Lesson 32	Exercise 35:1-5
	80	Lesson 32	Exercise 35:6-10
	81	Quiz Day	*Quiz Fourteen*
28	82	Review for Test	Review Questions
	83	Practice Test	*Test 7a*
	84	Test Day	*Test 7b*
29	85	Lesson 33	Exercise 36
	86	Lesson 34	Exercise 37
	87	Lesson 35	Exercise 38
30	88	Lesson 35	Exercise 38
	89	Quiz Day	*Quiz Fifteen*
	90	Lesson 36	Exercise 39
31	91	Review for Test	Review Questions
	92	Practice Test	*Test 8a*
	93	Test Day	*Test 8b*
32	94	Review for Comprehensive Exam	
	95	Review for Comprehensive Exam	
	96	Exam	*Comprehensive Exam*

LOGIC: ITS NATURE AND PURPOSE

Introductory Logic, pp. 1–6

STUDENT OBJECTIVES

1. Define *logic.*
2. Define *reasoning.*
3. Identify the three laws of thought.
4. Construct the logic chart, explain it, and answer questions about it.

TEACHING INSTRUCTIONS

1. Read the Introduction, "Logic: Its Nature and Purpose" (*Introductory Logic* pp. 1–6) aloud to the students (or have them take turns reading it). You can either read it in its entirety and then continue into the following steps, or stop and discuss the following as you go.
2. Ask students how they would define *reasoning.* After fielding weird answers and blank stares, explain that **reasoning means drawing proper conclusions from information we already have**. Give an example or two ("You smell smoke and decide something is burning. That's reasoning. Your friend is unnaturally quiet and you decide she's upset. That's reasoning.") Make sure students understand that reasoning is one of God's gifts to us so that we can get at truth; it is *not* what constitutes our being made in the image of God.
3. Write the definition of formal logic on the board: **Formal logic is the science and art of reasoning well.** Ask the students why they think that logic is a *science.* (Because it is about discovering the *rules* by which we reason.) Ask why they think logic is also an *art*. (Because the rules can be applied skillfully to discourse, we can't follow the rules woodenly; we have to practice logic skillfully. Have them think about what that might mean.) Make sure that students understand that logic was not created by man or God, but is an *attribute* of God that we see all over his creation.
4. Ask the students, "What is the first thing you need to build when you're building a house?" (A foundation. Something to build on.) Explain that reasoning is a lot like house-building: you always need something to build it on. Tell them that in logic we build on three rules, or laws. Remind students that impersonal laws don't have authority in themselves: somebody in authority has to give them. Emphasize that the three Laws of Thought are grounded in the Lawgiver, in the triune God.
5. Introduce the first law using the phrase "Jesus is Lord." Point out that there are only two responses to this statement, faith or unbelief, so the statement must be either true or false; you can't say, in a dreamy voice, "That statement is beyond truth and falsity." Write on the board the **Law of Excluded Middle: any statement is either true or false**. Insist that there is nothing in between. (Students may try to play devil's advocate and bring up "maybe" sentences or nonsense sentences. Be ready to explain that

a "maybe" sentence is still true or false, and a nonsense sentence is just that—nonsense.)

6. Introduce the second law with the same phrase "Jesus is Lord": if Jesus is Lord then Jesus is Lord. Explain that this might be kind of obvious, but a lot of people try to say things like "Well, 'Jesus is Lord' is true for you, but not for me." If something is true, it's true everywhere, for everyone. Write on the board the **Law of Identity: If a statement is true, then it is true**.
7. Explain, thirdly, that you can't agree that "Jesus is Lord" and disagree with it at the same time without having a split personality. Write on the board the **Law of Non-Contradiction: A statement cannot be both true and false.**
8. Explain that these laws might seem obvious, but that if we didn't assume them, we wouldn't be able to say anything for sure. But also point out that even though the world follows these laws, the world is nevertheless full of mystery, because God is full of mystery. He is Three in One. Ask the students for other examples of things we can't understand through logic alone. Emphasize that **logic must always give way to mystery**.
9. Draw the chart on page 6 of *Introductory Logic* on the board as you explain it. (Reassure anyone worried that while they need to be able to reproduce this chart, they do not need to understand all the concepts yet.) Explain that **formal logic deals directly with proper and improper modes of reasoning**, while **informal logic deals with operations of thinking that are indirectly related to reasoning**, such as defining terms, relating terms, and determining relationships between statements. Explain that formal logic also divides into two main branches: **Induction is reasoning to probable conclusions from examples or experience** (e.g., "Every cat I've ever had has purred when I petted it. Probably all cats purr when petted."), while **deduction is reasoning with certainty from premises to conclusions** ("All dogs bark. This is a dog. Therefore it barks."). Inductive arguments are either **strong** or **weak**; deductive arguments are either **valid** or **invalid**. The two branches of deductive reasoning are categorical and propositional logic. Tell students that in this book you will be studying both informal and categorical logic.

ASSIGNMENT

1. Have students review the three laws and practice drawing the logic chart.

LOGIC: ITS NATURE AND PURPOSE

God created man with the ability to reason: "Come now, and let us reason together, saith the Lord" (Is. 1:18). He did this so that we could communicate with Him and with one another. This enables us to love and obey Him. Reasoning means drawing proper conclusions from other information. A proper use of reason allows us to form rational statements, and to understand the statements that are made by others. It allows us, for example, to take universal statements such as "God has commanded all men everywhere to repent" and to apply them, first to ourselves and then to our neighbor: "We are men, therefore we must repent." Without the ability to reason, we would be unable to discuss, preach, read, hear the gospel, or follow God's commands. In other words, proper reasoning opens the mind so that it can close upon truth.

Some have assumed that this ability to reason is what constitutes man being created in the image of God. But there are several problems with this assumption. First, there are other creatures (like angels and cherubim) who have an ability to reason, but who do not bear the image of God the same way that man does. Another problem is that it implies that humans who are very young (e.g., a fertilized human ovum) or who are severely retarded cannot bear God's image, or that they do so imperfectly. Rather than treating reason as the image of God in man, it would be far better to treat reason as a gift that God gives (out of His own nature and character) to all intelligent creatures. The more He gives, the greater our responsibility to love Him, as Scripture says, "with all our minds."

Formal logic is the science and art of reasoning well. As a science, logic includes discovering and identifying the patterns or rules by which we reason. As an art, logic teaches how to follow those rules, without abusing them in a wooden (and unreasonable) way. About sixteen centuries ago, Augustine said this about the science of logic:

KEY POINT

Reason opens our minds so that they can close upon truth. Reason is a gift from God; it is *not* the single, essential aspect of bearing God's image.

DEFINITION

Logic is the science and art of reasoning well.

> And yet the validity of logical sequences is not a thing devised by men, but is observed and noted by them that they may be able to learn and teach it; for it exists eternally in the reason of things, and has its origin with God. For as the man who narrates the order of events does not himself create that order; and as he who describes the situations of places, or the natures of animals, or roots, or minerals, does not describe arrangements of man; and as he who points out the stars and their movements does not point out anything that he himself or any other man has ordained; in the same way, he who says, "When the consequent is false, the antecedent must also be false," says what is most true; but he does not himself make it so, he only points out that it is so. (*On Christian Doctrine*, book II, chapter 32)

KEY POINT

Logic is not created by God or man; rather, it is an attribute of God. It is not over God or independent of Him.

Logic is not devised by man, but neither is it created by God, like maple trees and dwarf stars are. Rather, it is an "attribute" of God which is reflected in creation. We need to be careful here, because it is not an attribute of God that is stated directly in Scripture, as His holiness, love, and righteousness are. But it is a characteristic of God that we see assumed everywhere in Scripture. We do not believe that logic is independent of God and over Him, which would mean that the triune God is not the sovereign God of the Bible. But neither do we believe that God could have created a nonsensical world where He was both the creator of it and not the creator of it. This leaves us with the assumption that all things are ultimately defined by God Himself, rather than by "rules." Since we want to learn how to reason as faithful Christians, we begin by assuming that all faithful thinking and reasoning is somehow sharing in this characteristic of God. So when we study logic faithfully, we are studying some of the divine reflection in the world around us.

The Laws of Thought

Keeping all of this in mind, we must be careful when dealing with "rules" and "laws" of logic. In order to reason well, we have to assume

certain very basic things that never show up as particular items in our argument. They are simply (and quietly) assumed. For example, if you were putting together an argument about light bulbs or tricycles, it is very important that they not turn into something else (like toaster ovens or catcher's mitts) halfway through the argument. If they did, the argument would just have to lie down in the corner and sob quietly. It could never get anything done.

Traditionally, these assumptions have been called the "laws of thought." There is nothing wrong with the *contents* of these assumptions, but there is a significant problem with *another* deeper assumption lying beneath them. That assumption is that you can have laws without a lawgiver, and that ultimately, you can have reason apart from the triune God of Scripture. All you need to do, it is thought, is postulate some laws of thought and off you go.

Because this is the case, we want to begin by showing how the laws of thought are actually grounded in the nature of the triune God, revealed in Jesus Christ. After we have done that, we will be able to discuss the traditional terminology. The reason for doing this is that many modernists have been guilty of thinking that impersonal "laws" have authority in themselves, which of course they do not.

Let's start with the basic Christian confession that *Jesus is Lord*. When God reveals Himself in Christ, the decision that must be made is whether to believe it or not. These are the only two options: faith or unbelief. This means that the statement *Jesus is Lord* must either be true or false. A faithful person confesses that it is true. An unfaithful person denies it as false. God does not leave open the option of saying something like, "I believe that the higher reality of the lordship of Christ cannot be contained in our paltry categories of true and false, and so I cannot say whether I believe in Him or not." Such a response is simple dishonesty masquerading as humility.

The fact that *any statement is either true or false* is one of the three traditional laws of thought, upon which much of the science of logic is based. This law of thought is called the **Law of Excluded Middle,** because it excludes the possibility of a truth value falling somewhere in the middle between true and false. Statements are either one or the other. If a statement is not true, then it is false, and vice versa.

DEFINITION

The ***Law of Excluded Middle***: Any statement is either true or false.

DEFINITION

The ***Law of Identity***: If a statement is true, then it is true.

DEFINITION

The ***Law of Noncontradiction***: A statement cannot be both true and false.

As Christians we confess that God is triune. If asked, we would say, "Yes, that is true. God is triune." Now if it is true that God is triune, *then it must be true that God is triune*. This is an application of **The Law of Identity**, which simply states that *if a statement is true then it is true*. For ordinary people in ordinary conversation, such rules are not thought to be necessary. But when people are fleeing from God, they will often take refuge in any folly, arguing that the truth of a statement can change in the middle of an argument. This law may be employed to answer the unbeliever who says, "Christianity may be true for you, but not for me." No. If the Christian faith is true, then it is true.

The third law says that *a statement cannot be both true and false*. This is called the **Law of Noncontradiction**. Without this law, we could not argue for the exclusive truth of any statement that we hold. We could try to assert, for example, that "Jesus is Lord." But our opponents could respond, "Oh, I agree that what you say is true. But it is also false." We see that if we deny these laws, we lose the possibility of all rational discourse.

Think for a moment what would happen to our faith if we were to allow someone to deny these fundamental assumptions. If we confess "God in three Persons, blessed Trinity," someone who denied the Law of Excluded Middle could say that this wonderful confession is not true, and it is not false. It is just wonderful, and perhaps even a little inspiring. One who denied the law of identity could say, "Yes, it is true that God is a Father for you, but it is *my* truth that She is a Mother." And one who denied the Law of Noncontradiction could say that God is our Father, and also, in the same way and in the same respect, He is not our Father. In other words, denial of these bedrock assumptions would make a hash out of the simplest Christian confession like the Apostles' Creed.

Having said all this, there is an important warning. The Bible does assume that the Father is the Father, and not the Son. The Spirit is the Spirit and not the Father. The Father is not "not the Father." At the same time, the Bible *also* teaches that the Father perfectly indwells the Son, the Son indwells the Father, and both with the Spirit are one God. Statements about the Father are not independent from statements about

the Son. Jesus said, "Anyone who has seen me has seen the Father." These truths do not deny the laws of thought but rather support them.

Through a wooden application of these laws, some logicians have gotten to the point where they cannot understand or appreciate poetry, metaphor, sacraments, or marriage. The world is full of "indwelling" and mutual partaking, because this is *also* what our God is like. In our study of logic, we must always leave room for mystery. We know that the Father is Father, and no one else. We know as well that the Father is not the Son. But we should also know that the Father reveals Himself perfectly in the Son.

KEY POINT

Logic must always give way to mystery. For example, we understand many things in terms of poetry, or sacraments, or the indwelling of the Trinity.

The Scope of This Book

The subject of logic may be divided into two main branches: **formal** and **informal**. Formal logic deals directly with reasoning, by considering the means of distinguishing between proper and improper modes of reasoning. Informal logic deals with operations of thinking that are indirectly related to reasoning, such as defining terms, relating terms to each other, and determining relationships between statements. Because informal fallacies are not formal methods of reasoning, they are also included under the branch of informal logic.

DEFINITIONS

Formal logic deals with the proper modes of reasoning. ***Informal logic*** deals with operations of thinking that are indirectly related to reasoning.

Formal logic itself may be divided into two main branches, **induction** and **deduction**. Induction deals with arguments of likelihood and probability. By induction we draw conclusions from facts or experience, conclusions which go beyond those facts. Inductive conclusions are never certain, but only probable. As such, they can be considered strong or weak, depending on how well experience supports the conclusion. They may also be strengthened by further experience. You can see that induction is the logic of the experimental sciences.

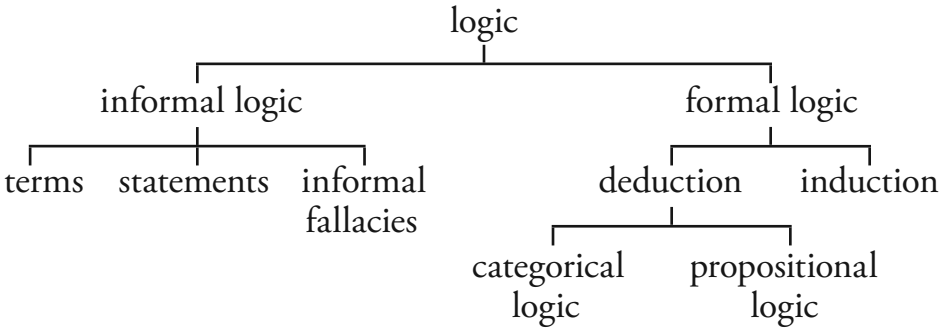
DEFINITIONS

Induction is reasoning with probability from examples or experience to general rules. ***Deduction*** is reasoning with certainty from premises to conclusions.

Whereas induction deals with arguments that are strong or weak, deduction deals with arguments that are valid or invalid. If valid, the conclusion follows from the premises, and it does so with certainty. A valid conclusion is one that is contained within the premises: if the premises of a valid argument are true, then the conclusion must be true. There are many branches of deductive reasoning. Two main branches are **categorical logic** and **propositional logic**. To the best of our knowledge, categorical logic was first developed as a science by

the Greek philosopher Aristotle (384–322 B.C.). Categorical logic deals with the **syllogism**, which is a type of deductive argument in which the conclusion connects one category (or term) with another, hence the name *categorical* logic. Propositional logic connects entire *propositions* together in arguments.

These branches of logic can be arranged as seen in the chart below:



This book is an introduction to the informal and categorical branches of logic. The next book in this series, *Intermediate Logic*, deals with the propositional branch of deduction. The point of all of this is to encourage students to begin the process of carefully "thinking God's thoughts after Him." The point of this book is *not* to teach us how to be quarrelsome with one another, nor to bring students to the false idea that the world is governed by some impersonal deity named Rules of Inference.

UNIT 1

TERMS AND DEFINITIONS

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THE PURPOSES AND TYPES OF DEFINITIONS

Introductory Logic, pp. 9–13

STUDENT OBJECTIVES

1. List and align the six purposes and five types of definitions and give examples.
2. Complete Exercise 1.

TEACHING INSTRUCTIONS

1. Read "Lesson 1: The Purposes and Types of Definitions" (*Introductory Logic* pp. 9–11) aloud with students. (Again, teach during or after the reading at your own discretion.)
2. Explain that **A *term* is a concept that is expressed precisely in one or more words.** A term is a verbal expression of an idea. Point to various objects around the room and make sure students understand that when you give these objects names they become terms, although the names are not themselves the terms. Explain that a single term can be expressed by many different words (e.g., *girl* and *puella* are two different words to describe the same term.) Also, one word can represent more than one term. Have students each write down their own definition of the word *mad*, and compare answers. Explain that the reason they all gave different definitions is that they are using the same word to describe different terms (e.g., *mad* can mean either "angry" or "crazy").
3. Give the definition of *definition*: **A *definition* is a statement that gives the meaning of a term.** Tell students that what you are going to investigate today are the purposes of different kinds of definitions, what they're *for*. Explain that in this chapter you will be examining six purposes and five types of definitions.
4. Write **1) Definitions show relationships** on the board. Use the example in *Introductory Logic* of defining *man* as *a rational animal*. What relationships does this definition imply that the man has? Well, it implies that he is related to other rational creatures, like angels, demons, and God, but also to other animals, like walruses, kittens, and dung beetles. The definition ties a string between man and other stuff; it connects them.
5. Write **2) Definitions remove ambiguity** on the board. Ask students what it means that a word is "ambiguous," and tell them that **Words are ambiguous when they have more than one possible meaning** (like the word "mad"). Explain that in lots of debates and arguments what the debaters get hung up on is definitions: they are using ambiguous words that mean something different to each person. When they finally define the ambiguous terms they have nothing left to argue about any more. Make sure students understand the book's example about the definition of love: you don't love your enemy the same way you love ice cream, or your baby sister. Explain that a definition that either shows relationships or removes ambiguity **by providing a single, established meaning of a term is called a *lexical definition***, i.e., the kind you would find in a dictionary.

6. Write **3) Definitions reduce vagueness** on the board. Emphasize that ambiguity is similar to, but not the same as, vagueness: **A term is vague when its extent is unclear.** A term itself may have a straightforward meaning, but there may be situations in which it is uncertain whether the term applies. For example, we call a man *tall* if he is over six feet, but a tree would have to be much taller than six feet before we would call it tall; so the meaning of *tall* is vague. A precising definition seeks to make more precise what was previously vague or fuzzy. Clarify that precising definitions are not dictionary definitions; they apply only to the situation they are used in. If we use *tall* to describe 6′5″ Harold, *tall* does not always and for everyone mean 6′5″. Ask students whether nouns can also be vague. (They can. How old does a girl have to be before she is a *woman*?)
7. Write **4) Definitions increase vocabulary** on the board. Ask students for some vocabulary words they have recently learned in English class. Or grab a dictionary, open to a random page and choose a word no normal person would know (Even better, have a particularly good word picked out beforehand.) Read the word and definition to them and tell them that their vocabulary just grew. Explain that **a stipulative definition is a definition given to a brand-new-just-invented word, or to an existing word applied in an new way**. Look up some new words in a recent dictionary, such as *blog*, *to google*, and *woot*.
8. Write on the board **5) Definitions can explain concepts theoretically**. Explain that sometimes we give a definition for a word not because we don't know what the word means, but because we're trying to understand the term behind it better. Explain the book's example of H_2O. This is a theoretical definition: a definition given to a term that is not understood, usually scientific or philosophical. Explain that people give theoretical definitions to lots of concepts we don't fully understand, like *spirit*, *life*, even *God*. Explain that if you accept a theoretical definition, you accept the theory behind it; if you accept the definition of man as an evolved ape, you accept the theory of evolution.
9. Write on the board **6) Definitions can influence attitudes**. Go over the book's three definitions of *abortion* and have students explain how each definition is supposed to make them feel about the act of abortion. Explain that all definitions like this are **persuasive definitions: they aim at persuading the listener one way or another toward the term being defined**. Emphasize that persuasive definitions can be used for either good or bad. Have the students give some more persuasive definitions for *school*, *government*, and *cats* from different points of view.

ASSIGNMENT

Have students complete Exercise 1, and go over it with them.

OPTIONAL EXERCISE

Play the Dictionary Game (cf. Balderdash). Pick an unknown word from the dictionary, and read it aloud to everyone. Have each student make up a definition for the word and write it on a sheet of paper. Write the real dictionary definition of the word on another sheet of paper and mix it in with the made-up definitions. Read all the definitions aloud and have students vote on which they think is the true definition of the word. Remind students to be thinking as they play about what goes into writing a definition and what they are doing when they try to invent definitions for words or figure out what the definition of a strange word might be.

LESSON 1

THE PURPOSES AND TYPES OF DEFINITIONS

A **term** is a concept with a precise meaning expressed by one or more words. A single term can be expressed by many different words. Words that are exact synonyms represent the same term. The English word *girl* and the Latin word *puella* represent the same term. Similarly, a single word can represent different terms. For example, the word *mad* can mean either "angry" or "insane."

A **definition** is a statement that gives the meaning of a term. The ability to define terms accurately is a valuable skill. Lawyers must continually define their terms, and may use precise, technical language to do so. The same is true for teachers, scientists, philosophers, theologians, and most other professionals. To demonstrate the value of this skill, let us consider some of the purposes that definitions serve.

1. *Definitions show relationships.* When a term is defined properly, the definition often gives some idea of the **relationships** which that term has with other terms. For example, if you were to define man as "a rational animal," your definition implies both that man has some relationship to other rational beings, such as angels and demons, and to other animals—bears, whales, and lizards. Or if bald is defined as "having no hair," its contradictory relationship with the term hairy is immediately apparent.

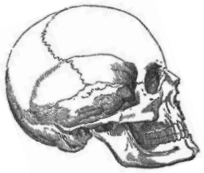
2. *Definitions remove ambiguity.* Words are **ambiguous** when they have more than one possible meaning. Commonly, in a discussion or a debate, ambiguous words are used without the participants being aware of the ambiguity. The result is a verbal disagreement that may be cleared up by defining terms. For instance, some people believe that Jesus' command to love your enemies is an absurd requirement because they are defining *love* to mean "believe the other to be a nice person," when in fact they know

DEFINITIONS

A ***term*** is a concept that is expressed precisely in words. A ***definition*** is a statement that gives the meaning of a term.

KEY POINT

Note the difference between a term and a word: one word can carry the meaning of many terms; the same term can be expressed with different words.



CAUTION

It is extremely important to define your terms at the beginning of any debate. You want to argue about substance, not words.

DEFINITIONS

An ***ambiguous*** word has more than one definition. A ***vague*** word is one whose extent is unclear.

their enemies to be quite wicked and depraved. But biblically, *love* means 'to treat the other person lawfully from the heart,' which is to be our behavior toward all men. If this definition is made clear, the people may still think that the command is impossible, but at least they no longer should see it as absurd.

A definition that shows relationships or reduces ambiguity by providing a single, established meaning of a term is called a **lexical definition**. This is the sort of definition one would find in a dictionary.

3. *Definitions reduce vagueness.* A problem similar to ambiguity is vagueness. A term is vague when its extent is unclear. The term itself may have a single, understood meaning, but there are "gray areas" where it is uncertain if the given term applies. This is a common problem in descriptive terms, such as *old, dark, tall, mature*. If a father tells his children it must be warm outside before they can swim in the lake, the children often immediately want vagueness reduced: "*How* warm?" If the father responds, "At least eighty degrees Fahrenheit," the issue is made clear. Or if you are asked to give a small donation for a gift for the secretary, you may want a definition to reduce the vagueness of the term *small*, like, "By small I mean five dollars." This type of definition is a **precising definition**, because it seeks to make more precise what was previously vague or fuzzy. Note that precising definitions would not be found in a dictionary; they apply only to the situation in which they are used.

CAUTION

A precising definition is very dependent on the situation in which it is used.

KEY POINT

Defining terms is a key way of communicating knowledge.

4. *Definitions increase vocabulary.* One of the most important elements of education is learning the meaning of unfamiliar terms. An increase in vocabulary means an increase in knowledge, which is why in English class students are taught "vocabulary words" and their definitions. In this very lesson you may have learned the definitions of terms like ambiguity and vagueness. Knowing these definitions helps us to make subtle distinctions and otherwise use language properly.

When a new word is invented, or an existing word is applied in a new way, it is given a **stipulative definition**. Such definitions, if widely accepted, increase the vocabulary of the language to which they are added. New words are continually adopted into English, such as words resulting from new inventions (*laptop*, added in

1985), from sports (*screwball*, 1928), from other languages (*macho* from Spanish, also 1928), or coined out of someone's imagination (*boondoggle*, from an American scoutmaster, 1957).

5. *Definitions can explain concepts theoretically.* Sometimes definitions are given for terms, not because the word itself is unfamiliar, but because the term is not understood. Such concepts require theoretical definitions, which are often scientific or philosophical in nature. For example, when your chemistry teacher defines water by its chemical formula H_2O, he is not trying to increase your vocabulary (you already knew the term *water*), but to explain its atomic structure.

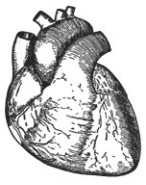
   Accepting a **theoretical definition** is like accepting a theory about the term being defined. If you define spirit as "the life-giving principle of physical organisms," you are inviting others to accept the idea that life is somehow a spiritual product.

6. *Definitions can influence attitudes.* Often terms are defined, not necessarily for the purpose of clarifying their meaning, but in order to influence the attitudes and emotions of an audience. Abortion has been defined as "the slaughter of innocent children" on the one hand, "the right of a woman to control her own body" on the other, or even the non-emotional "termination of a pregnancy." All these definitions aim at persuading the listener one way or another toward the term being defined, and as such are called **persuasive definitions**. Examples abound. Is democracy "mob rule" or "government by the people"? Is marriage "the institutionalized slavery of women by men" or "the blessed union of man and wife"? You can see the capacity of persuasive definitions for good or ill.

KEY POINT

Definitions may seem dry and logical, but they can be used persuasively. Knowing how to define terms well is a great advantage in debate.

SUMMARY



Definitions give meanings for terms. Definitions can show relationships between terms, remove ambiguity, reduce vagueness, increase vocabulary, explain concepts theoretically, and influence attitudes. Along with these purposes are the five types of definitions: lexical, precising, stipulative, theoretical, and persuasive.

EXERCISE 1 (16 points)

1. Write lexical definitions of the words *child* and *adult* that show the relationship between them. (3)

Child: A person who has not yet gone through puberty

Adult: A person who has gone through puberty

2. The word *grace* is an ambiguous word. Write two lexical definitions for the word *grace,* giving two of its different meanings. (2)

Grace: undeserved favor

Grace: beauty of motion

3. Write a precising definition of the word *soon* to clarify the vagueness in the sentence "I will be home soon." (2)

By soon I mean "before dinner."

4. Invent a stipulative definition for the word *ploff.* (1)

A crime that was nearly committed, but not quite.

5. Write a persuasive definition of the word *television* from the point of view of a mother who thinks her children watch too much of it. (4)

A television is a one-eyed brain sucker.

6. Write a short, imaginary dialogue between two people having a verbal dispute about the word *believe*. Then introduce a third person who settles the dispute by presenting lexical definitions for the word that eliminate the ambiguity. (Continue on the back if needed.) (4)

Smith: Satan certainly believes in God.

Jones: No, if Satan believed in God he would be saved, for all who believe are saved.

Johnson: By 'believe' I think Smith means 'takes as real' but Jones means 'puts his trust in.'

GENUS AND SPECIES

Introductory Logic, pp. 15–20

STUDENT OBJECTIVES

1. Define *genus* and *species.*
2. Construct genus and species charts.
3. Correct errors in genus and species charts.
4. Complete Exercise 2.

SPECIAL NOTE

Some of the students may have already dealt with the concepts of genus and species in a biology class. If so, make sure they understand that biology "hierarchies" are different from logic "hierarchies": logic doesn't have any levels other than genus and species (no family, order, class, phylum, or kingdom.)

TEACHING INSTRUCTIONS

1. Read "Lesson 2: Genus and Species" (*Introductory Logic* pp. 15–18) aloud.
2. Remind students that you are still discussing definitions, and that now you are narrowing in on a particular way of defining words and understanding the relationship between them. Explain that oftentimes we define terms by placing them inside a higher category or **genus: a term that is more general, broad, or abstract than the original term and includes it.** Give an example of a definition, such as "dime: a coin worth ten cents," or "kitten: a young cat." Ask students what the genera are that you're putting each of these words into ("coins" and "cats.") Explain that "dime" and "kitten" are species of "coins" and "cats." **A species of a term is a term that is more specific, narrow, or concrete than the original term and is included by it.**
3. Explain that terms can be placed in a genus and species hierarchy to show off the relationships between them. Have the students look at the hierarchy on p. 15. Explain that "food" is the overarching, Big Daddy genus over all these species. But point out that the *species* of "food" are also *genera* of other species. For example, "fruit" is a species of "food," but it is the genus of "grapes," "strawberries," "tangerines," and "pineapples." Even "grapes" is a genus of all the different kinds of grapes there are (white and red for starters). Ask students for some species of "cheese." Emphasize that the words genus and species are relative, because some terms can be both a genus and a species.
4. Have the students look at the first hierarchy on p. 16, and tell you (without looking ahead) what the genera and species are in this chart. Show that the species Informal logic and Formal logic are **mutually exclusive**: they don't overlap. They are also **exhaustive**: no other species of logic exist. Explain that *theoretically* every genus can be divided like logic into species that are both mutually exclusive and exhaustive, but that while species must always be mutually exclusive, usually they're not exhaustive. For example, it would be hard to come up with an exhaustive list of the species of "food."

5. Explain that this chart is only one of the many different charts you could draw for the genus "logic." You could have used a different "dividing principle" and come up with a different chart. When you divided the genus "logic" into "formal logic" and "informal logic" the dividing principle was "How directly related to reasoning is the term?" But say your dividing principle was "What is the goal of the term?" That would result in the second chart on p. 16. Same genus. Different species. Have the students each write their own species for "book," and compare the different dividing principles they used.
6. Explain that there are a several errors to avoid when constructing these genus and species charts. Ask students to tell you what's wrong with the first chart on p. 17 (without looking). Hopefully someone will say that there are women who are lawyers. Therefore the species are not mutually exclusive; they overlap. Make sure students understand that what caused this error was using two different dividing principles for the genus "people" at the same time: division by gender and division by profession. Write a few more examples of this error on the board, and have the students identify the conflicting dividing principles (genus: people / species: boys, paper-deliverers; genus: buildings / species: houses, palaces.)
7. Again, ask students to point out what's wrong with second chart on p. 17. This is trickier, but maybe someone will notice that "induction" has sneaked up in the chart; it is itself a species of formal logic and goes underneath it, not next to it.
8. Ask for the error in the third chart on p. 17. It should be pretty obvious: the genus "ball" is ambiguous. There are two different definitions of that word: it could mean a round toy that bounces or the place Cinderella met her prince.
9. Again ask for the error in the fourth chart on p. 17. The students should see that species are not supposed to be *parts* of the genus, but rather *types* of the genus. The species of "flower" are not "petal" and "stem," but "bluebell," "daffodil," and "morning glory" (among others). Ask the students how they could correct the bike chart.
10. Delve into the "Thinking Deeper" sidebar on p. 17 of *Introductory Logic*.

ASSIGNMENT

Have students complete Exercise 2, and go over it with them.

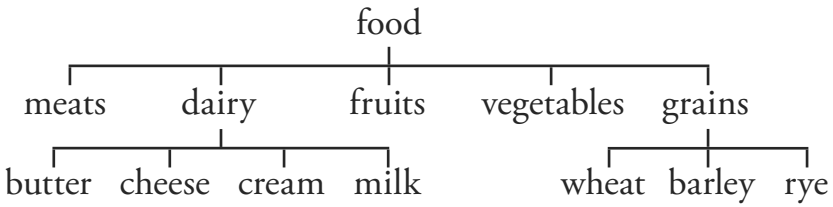
OPTIONAL EXERCISES

1. Write genus and species charts on the board and have students tell you if they are correct or incorrect, and if incorrect, why and how to correct them. Or have students do this for each other (and you.)
2. Start with a single term (ask for suggestions) and then expand it into a genus and species chart.

LESSON 2

GENUS AND SPECIES

Terms are often defined by being placed among a higher category, or **genus**. The genus of a term is more general, broad, or abstract than the term itself. The term under a genus is called the **species**, which is a type, kind, or example of the term. The species is more specific, narrow, or concrete than the genus. Terms can be placed in a **genus and species hierarchy**, thus clearly showing the relationships between them. For example, consider the hierarchy below:



Here we see the genus *food*, and under it some of the species of the term food: meats, dairy products, fruits, vegetables, and grains. Of these, the terms *dairy products* and *grains* are shown to be genera (the plural of genus) for the species under them. The genus *dairy products* is broader than any of its species, such as butter, because dairy products includes not only butter but cheese, cream, milk, and any other species that could be placed under it. The chart also shows that the term *grains* is the genus of wheat, barley, and rye. Of course, many other terms could be included as species of grains. Can you think of any?

The words *genus* and *species* are relative terms. Each term can be both a genus and a species—a genus of the terms below it, and a species of the term above it. Thus *grains* is both a species of food and a genus of wheat. This process can continue (although not indefinitely) both downward and upward. *Cheese* could be the genus for different varieties of cheese, such as Swiss, Parmesan, and Cheddar.

DEFINITIONS

A ***genus*** of a term is a term that is more general, broad, or abstract than the original term and includes it.

A ***species*** of a term is a term that is more specific, narrow, or concrete than the original term and is included by it.

KEY POINT

Genus and ***species*** are relative terms. Each term can be both a genus and a species.

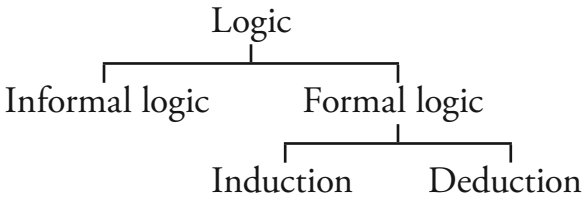
Food can be considered a species of *material* (if it is defined as "edible material"), and so on.

One caution: do not confuse the genus and species hierarchies of logic with the similar hierarchy you may have learned in biology. In logic, there are no levels other than genus and species—no family, order, class, phylum, or kingdom.

Now look at the genus and species hierarchy for the term *logic*.

CAUTION

Even though *genus* and *species* are biological terms, logical hierarchies are very different from biological ones.

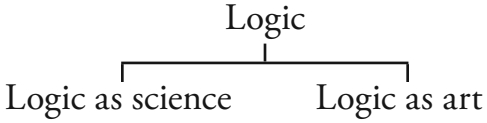


Two types of logic are identified as species: informal and formal. These species are **mutually exclusive**—they do not overlap. No branch of logic is both formal and informal. They are also **exhaustive**—no other types of logic exist. Theoretically, every genus can be divided into species that are both mutually exclusive and exhaustive. And while the species must be mutually exclusive, in practice they are rarely exhaustive. Are induction and deduction an exhaustive list of the types of formal logic?

KEY POINT

Genus and species charts can be drawn very differently depending on the principle used to divide and categorize terms.

In the chart above, logic is divided into *formal* and *informal* logic. The dividing principle there is, "How directly related to reasoning is the term?" Logic that deals directly with reasoning is formal, while logic that is more indirectly related to reasoning is informal. Other dividing principles could have been used which would result in a different chart, such as "What is the product or goal of the term?" In one case, for logic, the goal might be to discover and classify the rules of reasoning. In this case we would be considering the *science* of logic. In another case, the goal might be to produce persuasive arguments, which would mean we are considering the *art* of logic. Thus the chart would be:



There are several types of errors which we need to avoid while constructing genus and species charts. The first error was already mentioned: species which overlap, meaning that they are not mutually exclusive. Such an error exists in this chart:

People
Women Lawyers

This is an error because the species overlap: some women are lawyers. The error was caused by using two different dividing principles for the term *people:* division by gender and division by profession.

A similar error would occur when a term appears at the wrong level in the chart, such as in this example:

Logic
Formal logic Induction

Here the species overlap because induction itself is a species of formal logic, and thus should appear beneath it.

Another error can occur if a chart is being produced for an ambiguous word, with two different definitions in mind for the same word. For example, consider the word *ball*. This word could be taken in two senses: as a round toy, or as a kind of formal dance. This ambiguity could result in the following faulty chart:

Ball
Baseball Mid-winter ball

Finally, remember that a species is not a part of the genus, but rather a type or kind of that genus. The species of the genus *bicycle* may include *mountain bike*, but not *handlebars*. So when asked to make a genus and species chart, do not make a "whole to parts" chart like this:

Bicycle
Frame Pedals

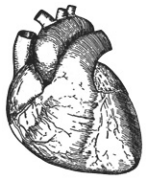
THINKING DEEPER

If the process of finding a further genus for any genus cannot continue indefinitely, it is reasonable to ask, What is the highest possible genus? If the genus of food is material, what is the genus of material? Possibilities include matter, substance, being, and so on. All of these are things created. But anything not created is God, since God alone is uncreated. Thus we are led to what theologians call the "Creator/creature distinction": all things are either Creator, or something created by the Creator. These are the highest genera of things. More could be said about the highest genus of abstractions (like *logic*), verbs (like *to run*), and so on.

CAUTION

Watch out for these basic errors when drawing genus/species charts: overlapping species, ambiguous terms, and confusing genus/species with part/whole.

SUMMARY



Terms can be organized into genus and species charts. A genus is a category into which a given term fits. A species is a type, kind, or example of a given term. Species should be mutually exclusive, and may be an exhaustive list.

Exercise 2 (20 points)

Explain the error or problem with each genus and species hierarchy shown. (2 each)

1. animals
   mammals | fish | air-breathers

"Mammals" and "air breathers" are not mutually exclusive.

2. hand
   fingers | thumb | palm

"Fingers," "thumb," and "palm" are parts of "hand," not species.

3. glasses
   sunglasses | wine glasses

The word "glasses" is being taken ambiguously.

4. airplane
   jet | biplane | Boeing airplane

"Boeing airplane" and "jet" are not mutually exclusive.

Fill in the genus and species hierarchy for each term given, identifying a) a genus for the term, b) another species under that genus, and c) a species of the term. (3 each)

5. (a) heavenly being
   angel | (b) cherub
   (c) archangel

6. (a) furniture
   chair | (b) bed
   (c) rocking chair

7. Draw a genus and species hierarchy that includes the following terms: ALGEBRA, BIOLOGY, CHEMISTRY, GEOMETRY, MATH, PHYSICS, SCIENCE, SUBJECT (6)