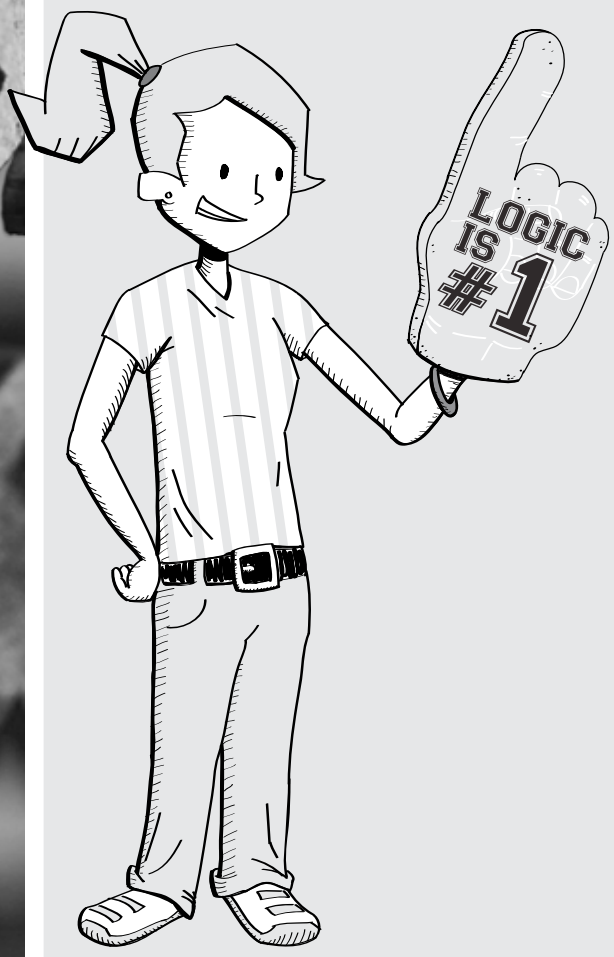
The Discovery of Deduction

An Introduction to Formal Logic

Teacher's Edition



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The Discovery of Deduction:
An Introduction to Formal Logic, Teacher's Edition
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Lesson 1.1

Formal vs. Informal Logic

Points to Remember

Formal Logic

- Reasoning in the abstract
- Mostly **deductive**
- Concentrates on understanding the **form** of an argument
- Can be analyzed using **symbols**

Informal Logic

- Evaluating the end product of reasoning
- Mostly **inductive**
- Concentrates on evaluating the **content** of an argument
- Deals with **ordinary-language arguments** in the interchange of ideas between people

> Perhaps someone will say, 'Why cannot you withdraw from Athens, Socrates, and hold your peace?' . . . I tell you that no greater good can happen to a man than to discuss human excellence every day . . . and that the unexamined life is not worth living.[1]
>
> —Socrates

Logic, the art and science of reasoning, is commonly divided into two main sections: **formal** and **informal logic**. (You may already have studied informal logic, particularly **fallacies**, in *The Art of Argument*.) Formal logic looks at reasoning in the abstract and focuses primarily on **deductive reasoning**, which deals with types of arguments in which the conclusion must be true if the premises used to support it are true. Formal logic studies how an argument is put together—the form, or structure, of arguments—rather than what the argument is about—the content, or substance, of arguments.

For example, consider the following argument: "All men are mortal. Socrates is a man. Therefore, Socrates is mortal." Formal logic is less concerned with the *content* of an argument—if "Socrates is mortal" is true or false—but very much concerned with the *form* of the argument—if the logical steps taken to get from "All men are mortal" to "Socrates is mortal" are **valid** or **invalid**. It is not that the content of deductive arguments is not important—it certainly is. However, when people argue deductively, they often begin with **statements**, which are called **propositions** in **deductive logic**. Most, if not all, people accept these propositions as true. They then use the process of deduction to discover new truths and ideas based on those accepted truths.

For instance, in the previous argument about Socrates, the first two propositions of the argument are a given. That is, no one would doubt those propositions. So, the focus of this argument would not be on whether or not the facts of the argument are true, because everyone knows they are, but rather on whether or not the argument is structured correctly. This is typically true of deductive arguments. Because the propositions in the argument are often considered to be true, the analysis of the argument focuses on the form of the argument to see if the reasoning process is correct. This concentration on form means that the content of a formal argument is more or less interchangeable, which is why the ordinary language of such arguments is often replaced with symbols. Using symbols to replace the ordinary language in an argument, and then evaluating the relationships between those symbols, will help you to learn how to analyze the form of arguments more easily.

Let's look at another example of this:

> All readers of excellent literature are people who think deeply.
>
> All habitual readers of Shakespeare are people who read excellent literature.
>
> Therefore, all habitual readers of Shakespeare are people who think deeply.

As you can see from the argument above, most, if not all, people would agree with both the first and second propositions. Therefore, the focus of this argument is not so much on the content of the propositions as it is on whether or not the argument is structured correctly so that we can know that the person making this argument is reasoning properly from **truth** to truth.

The most fundamental difference between formal and informal logic is that formal logic focuses on the structure of an argument, whereas informal logic focuses on evaluating the weight and relevance of the evidence. That is, informal logic focuses on evaluating the *content* of ordinary-language arguments, while deductive logic focuses on evaluating the structure of an argument. The ordinary-language arguments found in informal logic are usually inductive in nature, arguing from certain particular evidence or observations to a more general conclusion that is probable but not certain. One historian of logic described informal logic as "**dialectical** logic" because it is the language of debate and the interchange of ideas between people.[2] While it is true that people can use both types of logic individually or in conversation, people often use deductive logic, whether they realize it or not, to make sense of the world around them. In some ways, it is the simplest type of logic because people use single truths they already possess or believe in order to arrive at new truths.

As a matter of fact, even though you may not be aware of it, you use formal logic regularly. Every day, in order to discover new truths or new knowledge, you use propositions or truths that you believe to be true. Sometimes you use this process in order to discover simple truths, such as making observations about things you see every day. For instance, you might notice a child in a certain school uniform and reason, "All children I have seen who wear that uniform go to Seton Preparatory School, so I bet that child goes to Seton Preparatory School." Other times, you use formal logic to discover complex truths, such as when you make choices regarding ethics. For example, you might reason, "If I want to contribute to society, I should start by being a good neighbor. I think I will help my new neighbors move into their house today." (Of course, you are assuming in this argument that helping your new neighbors move into their house is the way to be a good neighbor.)

In order to help you understand how you can use formal logic to discover both complex and simple truths, consider the following examples. You have probably heard the famous Latin saying *Cogito ergo sum*, which, translated into English, means "I think; therefore I am." A French philosopher named René Descartes originally coined this famous statement.[3] Descartes was interested in the source of our knowledge and how we can know whether or not what we believe is accurate. In other words, because Descartes was aware of how easily human beings can be deceived by their thought processes, he wondered how humans could know whether or not any of their beliefs were actually true. Therefore, he decided he would question everything he believed in order to determine if he could find any truth that was undeniable or self-evident. As he did this, he soon realized that his doubts were evidence of his own thought processes. After all, a person must think in order to doubt, and there cannot be thought unless there is a sentient—

EVERY DAY, IN ORDER TO DISCOVER NEW TRUTHS OR NEW KNOWLEDGE, YOU USE PROPOSITIONS OR TRUTHS THAT YOU BELIEVE TO BE TRUE.

thinking—being generating those thoughts. Therefore, Descartes reasoned that the one undeniable truth was that his thoughts were evidence of his existence.[4]

If you were to translate this argument into formal logic, you would write something like this:

> All beings that think are (i.e., they exist).
>
> I think.
>
> Therefore, I am (i.e., I exist).[5]

Some people might argue that this is a waste of a deductive argument. After all, who really questions whether or not he exists? Although many people do not ponder questions such as this, philosophers certainly do, and deductive logic is one tool that allows them to reach conclusions and therefore learn more about reality, knowledge, or values.

But let's look at a more practical example of deductive logic, something about which ordinary people might think. Imagine that two different people are considering whether or not to vote for a particular political candidate whom we will call Candidate X. This candidate believes in increasing taxes to fund social programs. One person might argue the following:

> All candidates who wish to provide social programs care for the citizens of a nation.
>
> Candidate X wishes to provide social programs.
>
> Therefore, Candidate X cares for the citizens of the nation.

The other person might argue the following:

> All candidates who believe in increasing taxes will hurt the economy.
>
> Candidate X desires to increase taxes.
>
> Therefore, Candidate X will hurt the economy.

Notice that although these two people arrived at very different views of the candidate, they both used deductive logic to arrive at those views. That is, they used propositions that they believed to be true—the first two propositions in both of the arguments—to discover a third and new proposition. One person believes that Candidate X will care for the citizens of the nation. The other believes the candidate will hurt the economy. Both conclusions, or new beliefs, come from previous propositions the two people already believed to be true.

Did you know that this same deductive process often occurs in your mind when you buy a new product as a result of advertising? Let's say, for example, that you see an advertisement about a toothpaste that is guaranteed to whiten teeth. As a result of that commercial, you purchase the toothpaste and start using it. Your reasoning for purchasing the toothpaste might look something like this:

> People who want to have whiter teeth use toothpaste A.
>
> I want to have whiter teeth.
>
> I will use toothpaste A.

As you can see, people use formal deductive arguments to arrive at conclusions about things as simple as toothpaste and as complex as theories of their own existence. However, you should be aware that it is possible to misuse deductive arguments, whether you are reasoning about simple or complex things. Therefore, as we proceed through the rest of this book, you will learn both how to structure your own proper formal arguments and how to critique others' formal arguments. In this way, you will become proficient in the two key aspects of formal deductive logic: construction and analysis.

DEFINE

1. Logic:
The art and science of reasoning.

2. Formal Logic:
The branch of logic centering on the "form" of an argument. It is reasoning in the abstract, focusing on deductive reasoning, where the validity of an argument is based solely on the structure (form) of the argument.

3. Informal Logic:
The branch of logic that deals with ordinary-language arguments that tend to emphasize "inductive" rather than "deductive" reasoning. The structure or form of an argument is less the issue than the weight of the evidence, and the arguments are generally determined to be reasonably accurate with more or less probability.

4. Dialectical Logic:
Pertaining to the language of debate or to the interchange of ideas between two people, as opposed to the logic of one man reasoning all by himself.

ANSWER

1. What is the most important, or fundamental, difference between formal and informal logic?
Formal logic focuses on the structure of an argument, whereas informal logic focuses on evaluating the weight and relevance of the evidence.

2. Why aren't very many symbols used in informal logic?
Informal logic examines where arguments fall along the continuum of strength and weakness. Therefore, it is not an exact science and is not easily translatable into symbols. Formal logic deals with exact elements of arguments—the structure of an argument—and whether the structure is valid or invalid. Therefore, it is easily translatable into symbols.

DEDUCTION IN ACTION

Logic and Socratic Dialogue

Some of the most interesting examples of logic are the dialogues of an ancient Greek philosopher named Socrates. Socrates was devoted to helping people examine their thoughts, search for wisdom, and overcome error and illogical thinking. Socrates was so dedicated to this goal, in fact, that it eventually led to his death. Don't worry, those results are not typical to the study of logic. It is not likely you will suffer any negative results from pursuing logic (other than occasionally encountering your own illogical thoughts); it is more likely that you will gain a great deal of benefit from it. However, if you would like to learn more about the story of Socrates and his pursuit of wisdom, you can find it in a dialogue called the *Apology*.

You can find this dialogue, as well as the others mentioned in this book, at the following website: <http://store.doverpublications.com/0486270661.html>.

You can also download a copy of the *Apology* from this website: <http://www.wsu.edu/~dee/GREECE/APOLOGY.HTM>.

Read the Apology *and then answer the following questions:*

1. What did the Delphic oracle reveal to Socrates?
2. How did Socrates go about trying to prove the Delphic oracle wrong?
3. Why did Socrates' attempt to prove the oracle wrong anger some of his fellow citizens?
4. What were the two charges brought against him?
5. When Socrates was found guilty, he made a joke about what his sentence should be. What did he say his sentence should be, and why did he say it should be that?
6. Why, according to Socrates himself, could he not stop himself from doing what he was doing?

Note to Teacher: For answers see page 325.

Lesson 1.2

Deductive vs. Inductive Reasoning

Points to Remember

Deductive Logic

- Starts with **given propositions** or **axioms**
- Evaluated as either valid or invalid
- Deals with certainty (given the premises)

Inductive Logic

- Starts with observations (used as **evidence**)
- Evaluated as either strong or weak
- Deals with probability

> Logic is the anatomy of thought.
> —John Locke[1]

The Art of Argument emphasized that informal logic tends to be more inductive and formal logic tends to be more deductive. First, let's quickly review the differences between inductive and deductive reasoning. **Inductive reasoning** tends to start with evidence that we can observe and compile. For example, if someone were studying the characteristics of excellent schools, he would carefully examine several examples of schools that are considered to be excellent in order to discover common characteristics between those schools. Those common characteristics become the evidence upon which his inductive argument will be based.

Inductive logic often works toward **generalizations** that are reasonably accurate with more or less **probability**. This means that inductive reasoning does not lend itself to absolute certainty, which is why inductive arguments are evaluated as "strong" or "weak." In our example of the study about the characteristics of excellent schools, the researcher might discover that all of the schools he examined had high expectations for their students. Therefore, he might claim that one characteristic of an excellent school is that it has high expectations for its students. It would be difficult to prove absolutely that this characteristic is a cause of a school's excellence, but the more careful and thorough the work of the researcher, and the more schools he examines in his study, the more probable his conclusions become.

Deductive reasoning, on the other hand, does not start with observations of evidence so exclusively, but rather with a proposition (a statement that can be proven true or false) that is used as a given to start an argument. Examples of propositions that could be used in such an argument are: "All men are mortal" or "Thoughts indicate a thinking being" (do you remember Descartes' argument from the last chapter?). These propositions are generally assumed as a starting point, or as givens (things that are accepted as self-evident), and are often called axioms or **postulates**. Deductive reasoning focuses on things that are either "black" or "white," which is why deductive arguments are evaluated in the more

certain terms of "valid" or "invalid." In contrast, inductive reasoning tends to focus on "shades of gray." For example, if you consider the postulate "All men are mortal," you will note that men are either mortal or they are not. This is a black-or-white issue, so you know this postulate is based on deductive reasoning. On the other hand, if you consider the characteristics that create an excellent school, you will note that they are more difficult to determine absolutely, which places them in the "shades of gray" area of inductive reasoning.

Since we can analyze inductive reasoning, just as we can deductive reasoning, there are approaches to induction that could be classified as "formal logic."[2] After all, inductive arguments can be analyzed in ways that focus only on the form or structure of the argument and in ways that don't involve the back-and-forth, interpersonal dimension of debate between people. But remember, we are discussing inductive reasoning in this chapter for the sake of review. The primary focus of the rest of this book will be on deductive reasoning, with only an occasional mention of inductive logic as a basis for comparison.

Review
Define

1. Inductive Reasoning:
A method of determining the validity of an informal argument, which tends to start with evidence that can be observed and compiled and works toward generalizations that are reasonably accurate with more or less probability. Inductive arguments are said to be either "strong" or "weak."

2. Deductive Reasoning:
A method of determining the validity of a "formal argument" in which the conclusion must, necessarily, be true if the premises used to support it are true. Arguments are said to be "black" or "white" and cannot be gray.

3. Evidence:
Facts used to support a conclusion or hypothesis.

FILL IN THE BLANK

1. Inductive reasoning tends to start with _____evidence_____ that we can _____observe_____ and compile. It often works toward _____generalizations_____ that are reasonably accurate with more or less _____probability_____. This means that inductive reasoning does not lend itself to absolute _____certainty_____.
2. Deductive arguments are evaluated as either _____valid_____ or _____invalid_____, and inductive arguments are evaluated as either _____strong_____ or _____weak_____.

DEDUCTION IN ACTION

A Look at Philosophy

Note to Teacher: For answers see page 325.

Throughout this book, you will notice that we include all sorts of different arguments to help you understand how deductive logic works. A person can actually use deductive reasoning in any type of argument concerning any subject. However, there are some fields of study or areas of life in which people may more commonly rely on deductive logic, and therefore, in those situations, you may see more of those types of arguments than others.

For example, deductive logic is integral to the work, study, and thought processes of philosophy. The word "philosopher" derives from the Greek words *philos*, meaning "love," and *sophia*, which means "wisdom." Philosophers, therefore, are lovers of wisdom, and they attempt to discover wisdom and truth about the underlying concepts and beliefs held by mankind. As you can imagine, since beliefs and concepts aren't things that are easily measured, philosophers cannot do scientific experiments to test whether they are correct or incorrect. Therefore, they often use ***a priori*** truths in order to discover new truths, which, of course, is deductive logic. In fact, Peter Kreeft, a modern philosopher, said, "Logic is to philosophy what a telescope is to astronomy or a cookbook to a meal. It is an instrument. It is no substitute for the real thing, but it makes the 'real thing' work much better."[3] Philosophers generally prefer to use deductive rather than inductive arguments because deductive arguments are certain, whereas inductive arguments are only probable.

You can see this reliance on deductive philosophy in the works of the earliest philosophers. For example, the following quote is by early Greek philosopher Anaximander concerning his beliefs about the origin of men. Because Anaximander could not directly observe the origin of man, he attempted to figure out the truth using logic. Notice his argument:

> [Anaximander said] that in the beginning man was born from animals of a different sort, arguing from the fact that whereas animals are soon able to fend for themselves, the young of humans are dependent for a long period of time. Hence, if man had been in the beginning as he is now, he would never have been able to survive.
>
> He held that there arose from warm water and earth creatures which were either fish or fish-like. Inside these humans were formed, remaining like fetuses until the time of puberty. At this time the creatures broke open, and men and women already capable of getting food for themselves emerged.[4]

Put Anaximander's argument into your own words. Then answer the following question: What a priori *truth does Anaximander use to reach his new truth?*

Lesson 1.3

Categorical vs. Propositional Logic

Points to Remember

Categorical Logic

- Basic building block is a category of things called a **term**
- Building blocks are connected by the "being" verb[1]

Propositional Logic

- Basic building block is a statement, called a proposition
- Building blocks are connected by **logical operators**

> He that cannot reason is a fool.
> He that will not is a bigot.
> He that dare not is a slave.
> —Andrew Carnegie[2]

As you have probably realized by this point, there are several different types of formal logic. You may wonder, as you learn more about them, why it is necessary for them to exist. You may also wonder how to move between the different types of logic and how to use them properly in conjunction with one another.

To understand the *purpose* of the different types of logic, it may help you to consider that they are like the different magnification settings of a microscope. These different levels of magnification allow you to go from a broad view of something to a very close, detailed view. Similarly, the different types of logic allow you to look at human thought from broad or detailed perspectives.

Let's look at this analogy using the two most widely studied types of formal logic: **categorical logic** and **propositional logic**. Keep in mind that the differences between these two types of formal logic are similar to the differences between the levels of a microscope's magnification. The basic component of categorical logic is an individual noun (or noun phrase) called a term, which represents a **category** of things. When we use categorical logic, it is like we are examining human thought very closely and in great detail, as though we are using a very high magnification on a microscope. On the other hand, the basic building block of *propositional* logic is an entire sentence called a proposition. When we use propositional logic, it is like we are looking at thought processes from a distance in order to get a better view of more comprehensive, complex thinking operations. It is as though we are looking at them using a very low magnification on a microscope.

Let's look at a few examples to illustrate this point more clearly. In the first argument that follows, there is a **categorical syllogism**, which is the key argument type in categorical logic. You will notice that it deals with three single, specific categories: people, compassionate beings, and me (I). Through connecting these three categories, a specific point is made: I should be compassionate.

All people should be compassionate beings.

I am a person.

Therefore, I should be a compassionate being.

Now look at the following example of propositional logic:

If I want to improve the world, I should help my neighbor.

I want to improve the world.

Therefore, I will help my neighbor.

This second type of argument is called a **hypothetical syllogism**, and it is one of the argument types of propositional logic. You will notice that it is a more complex argument because it is dealing with a hypothetical, possible scenario—the possibility that I might want to improve the world and what I should do based on that desire. Although I do discuss some other things—the world, my neighbor, and me—I do so in the context of this broad, hypothetical look at the world.

It is accurate to say that categorical logic, while it can deal with abstract concepts, is primarily used to reason about a few *actual* things, while propositional logic reasons with complex reasoning situations, such as **hypotheticals**, **either-or scenarios**, or **dilemmas**. To return to our microscope analogy, categorical logic helps us examine specific things up close, as if under high magnification. Propositional logic helps us examine things from a distance to get the big picture and general outline of a thing or idea, as if under low magnification.

For another example, consider the following situation. The other day, I went to meet my friend at the school at which she works in order to help her set up her classroom. Unfortunately, on the way there, I got lost and ended up being forty minutes late to meet her. When I got there, my friend said, "I'm glad you're OK. I thought that either you had forgotten about our meeting or that something had happened to you on the way over. Since I didn't think you would forget the meeting, I was worried something had happened." In this situation, my friend was using propositional logic. She used entire propositions, or complete thoughts, to reason about why I was late. You will notice that her use of propositional logic allowed her to reason about the whole scenario in general, and it also allowed her to hypothesize different reasons why I might be late.

In contrast, if my friend had used categorical logic, she might have reasoned like this:

All people who are late have forgotten their appointments.

My friend is late.

Therefore, my friend has forgotten her appointment.

Or, she could have reasoned:

All people who are late have been in accidents.

My friend is late.

Therefore, she has been in an accident.

You will notice that some similar thought processes occur in both the propositional and the categorical arguments. However, the categorical argument deals with one concrete idea at a time, as if looking at the situation up close, detail by detail. The propositional argument examines complex, possible scenarios all at once, as if looking at the entire situation from a distance.

Now let's switch to a different analogy that will help you understand how to *move between* the different types of logic. We could say that the different types of logic are like different cultures. If you traveled to another country, you would most likely find that its culture was different from yours. Even though you would notice some things that were similar to your own culture, such as the presence of stores, holidays being celebrated, and some sort of transportation system being in place, there would be enough differences that you would probably have to adapt to the new culture quite a bit. Different cultures tend to have unique laws, procedures, customs, and symbols to which newcomers must adjust. You might experience a bit of culture shock at first, but soon you would adjust and be able to appreciate the uniqueness and adventure of the new place.

Just as different cultures contain unique procedures, rules, languages, and practices, so do the different types of logic. Another similarity is that all types of logic have some things in common with one another, as do cultures. For

instance, you will find that the different types of formal logic use some similar terms, and that all of the different types of arguments have rules for constructing good arguments and avoiding bad ones. Such comparisons will help you to move between the different types of logic because you will be able to follow the common concepts between them. However, you will also find, just as with understanding a different culture, that you must learn the different aspects of each individual logic system in order to understand and appreciate it properly. Although this may frustrate you at first when you encounter a new type of logic, realize that soon you will adapt and be able to appreciate it for its own sake.[3]

At this point, you may be wondering why we are starting with categorical logic. After all, there are a number of other logic textbooks that begin with propositional logic (or a branch of it sometimes called truth-functional logic).[4] There are several reasons for our decision to start with categorical logic, and if you are like many students, it may help you to study this book more thoroughly if you understand the logic behind the way it is set up.

First, categorical logic is the more traditional logic. It was seen as essential for understanding the thinking processes of many foundational thinkers, such as **Plato**, **Aristotle**, **Augustine**, and **Aquinas**. When you read the works of these philosophers, you will find that their writing mirrors the categorical thought processes that you will learn in this book. By studying categorical logic, you will be able to better understand their writing. Furthermore, categorical logic was developed first historically, and unless there's a good reason not to, why not teach first things first? Lastly, our experience has been that students generally find categorical logic easier to understand because it deals with fewer forms. Therefore, when students study categorical logic first, they move from simpler to more complex forms of logic in a systematic manner, much like how students studying math move from simple calculations to more complex operations as they gain more advanced math skills.

As you begin the study of categorical logic, realize that you will learn to analyze the basic units of thought in a clear, systematic manner so that you can more easily proceed to examining complex arguments. In addition, you will follow the learning trajectory of many of history's great thinkers and philosophers.

Review

Define

1. Categorical Logic:

The branch of logic pioneered by Aristotle that deals primarily with categories of things. In a categorical argument, an argument can be represented with symbols, and each of those symbols represents a "term," or a word or phrase, that describes a "category" of things. Categorical logic is always deductive logic, so only the structure or form of the argument is used to determine validity. Example: "All men are mortal" becomes "*All S is P*."

DEFINE (CONTINUED)

2. Propositional Logic:

A type of logic that deals with propositions and their relationship to each other.

FILL IN THE BLANK

1. While the basic building block in categorical logic is an individual word called a _____term_____, which represents a basic category of things, the basic building block of propositional logic is an entire sentence, called a _____proposition_____.
2. You could say that categorical logic is like the _____high_____ magnification setting on a microscope because it allows you to examine things in _____detail_____. On the other hand, you could say that propositional logic is like the _____low_____ magnification setting on a microscope because it allows you to examine things from _____a distance_____.

EXPLAIN

1. In your own words, explain why it is important to examine issues from a close, detailed perspective, as well as from a broad, more comprehensive perspective. Provide an example of a subject in which you are currently interested or that is important in our culture right now. Explain at least two different things you could learn from examining this topic up close and in detail, as well as from a distance in a more general manner.

It is important to examine issues from a close perspective because it allows a person to notice specific details and individual ideas. Examining something from a broad, more comprehensive perspective allows a person to look at the situation or subject as a whole and deal with possible, hypothetical situations. It might also help people to notice general trends or patterns about a situation, as well as the causes and effects of the situation. For example, consider the war in Iraq. If a person examines this situation in close detail, he or she will be able to make observations and arguments about the people of Iraq, specific wars, and specific goals. However, in looking at the war from a distance using propositional logic, a person would be able to reason about different causes of the war and possible results, given different hypothetical actions that the U.S. might take in Iraq.

Explain (continued)

2. In your own words, explain why it might be helpful to consider the different types of logic as different cultures. Provide at least two reasons.

It can be helpful to look at the different types of logic as different cultures because doing so will help you realize that it is normal to feel a little bit of "culture shock" when moving from one type of logic to another. Furthermore, it can also help you realize that just as there are similarities between different cultures that can help a person adapt, there are also similarities between the different types of logic that can help a person adapt from one type of logic to another.

Deduction in Action

Logic and the Movies

As mentioned before, people can use deductive logic to argue about any topic in any field of study. Having said that, sometimes deductive logic shows up in the oddest places and in the oddest ways. Take the movies, for instance. One of the most famous British comedies is a movie called *Monty Python and the Holy Grail*. In one very famous scene in this movie, some townspeople try to prove that a local woman is a witch. A "wise" man in the crowd, Sir Bedevere (along with a little help from a visiting King Arthur), helps them with their logic, and the result is memorable, to say the least. Read the following dialogue and then answer the questions at the end.

Various Peasants: Witch! A witch! We've got a witch!

First Peasant: We have found a witch. May we burn her?

[Various calls to burn her.]

Sir Bedevere: How do you know she is a witch?

Peasants: She looks like one. [Various calls to burn her.]

Sir Bedevere: Bring her forward.

Accused Girl: I'm not a witch! I'm not a witch!

Sir Bedevere: But you are dressed as one.

DEDUCTION IN ACTION (CONTINUED)

Accused Girl: *They* dressed me up like this. And this isn't my nose; it's a false one.

Sir Bedevere: Well?

First Peasant: Well, we did do the nose.

Sir Bedevere: The nose?

First Peasant: And the hat, but she's a witch.

[Yeah, burn her!]

Sir Bedevere: Did you dress her up like this?

Peasants: No. No. No. No. No. Yes. Yes, a bit. A bit. A bit. A bit. She has got a wart.

Sir Bedevere: What makes you think she's a witch?

Second Peasant: Oh, she turned me into a newt.

Sir Bedevere: A newt?

Second Peasant: I got better.

Third Peasant: Burn her anyway! Burn her!

Sir Bedevere: Quiet! Quiet! Quiet! Quiet! There are ways of telling whether she is a witch.

Peasants: Are there? What are they? Tell us!

Sir Bedevere: Tell me, what do you do with witches?

Peasants: Burn them!

Sir Bedevere: And what do you burn apart from witches?

First Peasant: More witches!

Third Peasant: Wood!

Sir Bedevere: So, why do witches burn?

First Peasant: 'cause they're made of . . . wood?

Sir Bedevere: Good!

Peasants: Oh, yeah.

Sir Bedevere: So how do we tell whether she is made of wood?

First Peasant: Build a bridge out of her!

Sir Bedevere: Ah, but can you not also make bridges out of stone?

First Peasant: Oh, yeah.

Sir Bedevere: Does wood sink in water?

First Peasant: No, no.

Third Peasant: It floats. It floats!

First Peasant: Throw her into the pond!

Peasants: Yeah! Yeah! The pond!

DEDUCTION IN ACTION (CONTINUED)

Sir Bedevere: What also floats in water?

Peasants: Bread! Apples! Very small rocks! Cider! Gravy! Cherries! Rum! Churches! Lead!

King Arthur: A duck.

Sir Bedevere: Exactly. So logically. . . ?

Peasants: If she weighs the same as a duck . . . she's made of wood.

Sir Bedevere: And therefore. . . ?

Peasants: A witch? A witch! She's a witch! Burn her!

Sir Bedevere: We shall use my largest scales!

[Various cries.]

Sir Bedevere: Remove the supports.

[Various cries.]

Peasants: A witch! A witch!

Accused Girl: It's a fair cop.*

Sir Bedevere: Who are you who are so wise in the ways of science?

Arthur: I am Arthur, king of the Britons.

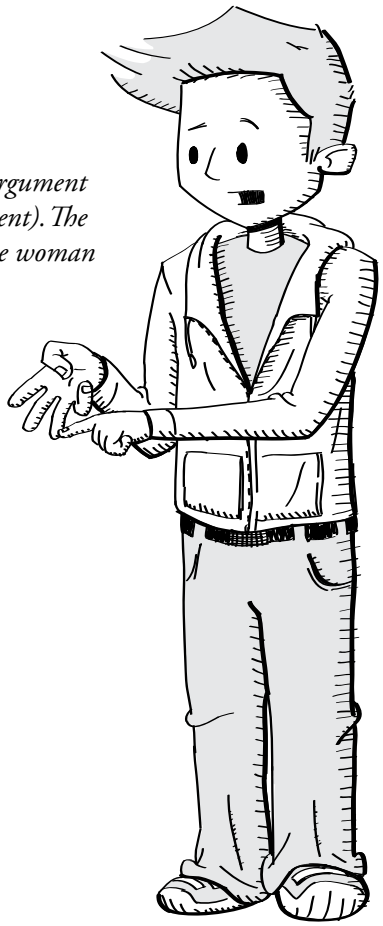
Sir Bedevere: My liege.[5]

*"Cop" is a slang term meaning "catch, capture, or purchase."

From what you know about deductive logic so far, see if you can write the aforementioned argument in some semblance of a deductive argument (mind you, it's certainly a silly deductive argument). The "argument" begins when Sir Bedevere claims that there are ways of telling whether or not the woman is a witch.

Note to Teacher: For answers see page 326.

While we would not recommend *Monty Python* in general, there is another skit, called "The Argument Clinic," which is funny and, in our opinion, clean and appropriate for middle and high school students. It's more entertaining than thought provoking, but it does illustrate, in extreme hyperbole, the ineffective or frustrating argument techniques we use at times. You can find the clip at: <http://www.youtube.com/watch?v=teMlv3ripSM>.



Lesson 2.1

Part I: Aristotle Gets the Ball Rolling

Classical Origins and Medieval Recovery

Points to Remember

1. The Greek philosophers, particularly Aristotle, developed formal logic.
2. The rediscovery of logic was central to the rebirth of higher learning and the advancement of philosophy and science.

> It is the mark of an educated mind to be able to entertain a thought without accepting it.
> —Aristotle[1]

It may help you to think more clearly about logic in general and the different types of logic specifically if you think about it as a discipline that aids people in the search for truth. Since the beginning of time, people have been interested in finding truth or in being certain about what they know, or what they think they know. As people began to think about this process and the search for truth, they began to consider rules by which they might be able to determine if their reasoning was good or bad or their beliefs true or false. In determining this, they believed it would aid them in analyzing their beliefs effectively.

The Egyptians and other ancient people first began experimenting with these concepts when they began using geometric concepts to build amazing buildings, such as the pyramids in Egypt and some of the temples in Central and South America. The basis of geometry is the postulate, or axiom, which is a truth that is accepted as a given. For instance, it is accepted as a given that the three angles of a triangle always equal 180 degrees. Everything from geometry flows from these axioms, or postulates. Therefore, geometry would work like this: Since axiom A is true and axiom B is true, then C must follow. Since the Egyptians and ancient peoples in the Americas used laws like this, they were familiar with the concept of logic, although they may not have had a formal program of study centered on it.

However, as the ancient Greek civilization developed, people became interested in identifying and codifying the logic they found in geometry and other reasoning processes they were using to discover the truth of the world around them. In fact, the ancient Greek philosopher Aristotle, who lived from 384 to 322 BC, wrote the first logic "textbook" that has survived the passage of time. This collection of his writings is called the *Organon*, which means "instrument." This title was used because logic was seen as an instrument, or tool, of science and philosophy.[2] Aristotle addresses various topics in the *Organon*, including informal fallacies, but its primary focus is categorical logic.[3] Aristotle was fascinated by all sorts of subjects, including philosophy, politics, science, and medical studies. He believed that our senses were the main vehicle through which we discovered the truth. Therefore, he believed people should determine those things which could not be denied by the senses and then derive

everything deductively from those *a priori* (self-evident) truths. Because of Aristotle's influence, categorical logic dominated the field of logic in the ancient world. Even today, categorical logic is sometimes called Aristotelian logic.[4]

It may seem as though a great philosopher such as Aristotle would have easily been able to analyze and categorize all of the rules of logic in his lifetime. However, logicians and philosophers over the years have realized that our thought processes and reasoning systems are so complex that they take a great deal of consideration and analysis from multiple angles. For instance, a school of philosophers called the **Stoics**, founded in the third century BC,[5] loved to study arguments, propositions, and paradoxes that did not fit Aristotle's system of logic.[6] For example, the Stoics liked to study problems in logic such as the liar's paradox. This paradox occurs when someone who has claimed that he always lies utters the phrase, "I am lying." As you can see, this presents a problem. Do we simply accept his assertion that he is, indeed, lying? Or, do we assume that he is lying when he says he is lying and, therefore, he is not lying? The Stoics dealt with propositions and arguments that were more complex than those with which Aristotle's logic dealt.

Although Aristotle's studies in logic did not exhaust the study of human thought, his studies were so significant, useful, and profound that the study of Aristotelian logic dominated the field of logic even into the Middle Ages (AD 456-1400). At first, much of the learning of the classical world was lost in the wake of the fall of Rome and the confusion during the transition to the medieval era. Medieval scholars, therefore, had a considerable amount of rebuilding to do in retrieving and translating past writing in the area of logic.[7] However, once Aristotle's works had been recovered and translated, along with several other key logic texts, medieval scholars were convinced of logic's importance. As William of Ockham (1285-1347), a famous medieval logician, wrote, "Logic is the most useful tool of all the arts."[8]

During the Middle Ages, logicians, scholars, and philosophers recognized that logic was a necessary tool for the progress of philosophy and science. In addition, people desired to understand the world in an orderly way after experiencing so much chaos and confusion in the early Middle Ages, during which time there had been little time for contemplation of how the world worked. Consequently, scholars in the later Middle Ages were particularly attracted to the orderly categories of Aristotle.[9] In fact, many medieval scholars used Aristotelian logic to prove Christian doctrine.[10] For instance, Thomas Aquinas (1225-1274) used Aristotle's logic to develop arguments for the existence of God. The emphasis on Aristotelian logic, at the expense of other approaches, continued throughout the Middle Ages and into the Renaissance. At that time, logic took a firm place, along with grammar and rhetoric, as a member of the "trivium," the three liberal arts considered foundational to education. As people began to rediscover the learning and knowledge that had been lost in the collapse of the Roman Empire, Aristotle's organized system of thinking and classification helped them to begin to make sense of a seemingly chaotic world.

Review Answer

1. Who wrote the first known textbook on logic? What was its title and what did that title mean?

Aristotle wrote the first known logic textbook. It was entitled *Organon*, which means "instrument."

ANSWER (CONTINUED)

2. Summarize the contribution to the field of logic made by the three philosophers (or group of philosophers) listed below.

a. Stoics:

They liked to study propositions that did not fit Aristotle's system of logic.

b. Thomas Aquinas:

He tried to show that Aristotle's logic and Christianity could be reconciled. He used Aristotle's logic to argue for the existence of God.

c. William of Ockham:

He recognized the value of logic and said, "Logic is the most useful tool of all the arts."

3. Explain why Aristotle's categorical logic might have especially appealed to people during the Middle Ages.

Aristotle's logic was systematic and dealt with clear, distinct categories. Because of this, it was a very organized system of logic. Due to all of the chaos during the Middle Ages, organization and systematization were attractive qualities to the people living during that time.

4. For another interesting look at the complexities of logic, go to the website listed below and study Zeno's most famous paradox, which is the riddle about Achilles and the Tortoise: <http://www.mathacademy.com/pr/prime/articles/zeno_tort/index.asp>.

In the space provided below, explain Zeno's paradox and why it presents a challenge to logicians even today.

The following is a basic summary of the idea. Tortoise challenges Achilles to a race on the condition that Tortoise gets a head start of ten meters. Once Achilles starts, he must cover the distance of the head start he gave Tortoise. However, as he is covering this distance, Tortoise moves ahead another distance. Now Achilles must cover this distance as well. But, as he is doing this, Tortoise moves ahead another distance, which Achilles must make up as Tortoise, yet again, is moving ahead another distance while Achilles is still covering the previous distance. The argument goes on *ad infinitum*. The puzzler of this paradox is that, while we know that Achilles certainly catches up to Tortoise, the logic of the scenario—which is that Tortoise is always moving forward and Achilles will never be able to catch up—seems irrefutable. This is why it still puzzles logicians and philosophers today because it is a seemingly logical argument that leads to an illogical conclusion.

ANSWER (CONTINUED)

5. William of Ockham, a medieval logician mentioned in this chapter, is known for his famous principle called Ockham's razor. Do some research about this principle and then explain its basic idea in the space provided below. You can find information about this principle at the following site: <http://pespmc1.vub.ac.be/occamraz.html>.

Ockham's razor can be summarized in this way: The explanation of any phenomenon should make as few assumptions as possible. Another way to state it is this: The simplest answer is usually the best one.

DEDUCTION IN ACTION

Think About It

We want to get you warmed up to thinking about evidence, reasons, and arguments. Look at the quote at the beginning of the chapter and provide an answer for these two questions:

1. Why is it important to be able to entertain an idea without accepting it?
2. Why is entertaining an idea without accepting it especially hard to do?

Note to Teacher: For answers see page 326.

Lesson 2.2

Part II: Aristotle Is Lost and Then Found

The Growth and Divergence of Modern Logic

Points to Remember

1. During the Renaissance and Reformation, people began to question the prominent status of Aristotelian logic.
2. People like Francis Bacon, John Stuart Mill, and George Boole attempted to address some of the weaknesses and limitations of Aristotelian logic.

> The logic of words should yield to the logic of realities.
> —Louis Brandeis[1]

During the Renaissance and Reformation, which took place between the fourteenth and seventeenth centuries, people began to question the prominent status of Aristotelian logic in the curriculum. There were several reasons why this occurred. First, new avenues of thought and new research tools emerged. People became increasingly interested in experience and the information acquired through the senses as a basis for knowledge. For example, the English scholar Francis Bacon (1561-1626) wrote a highly influential work entitled *Novum Organum*, which means "new instrument." Bacon insisted that more attention needed to be paid to inductive logic and less to the deductive logic stressed by Aristotle. Bacon believed that rather than reasoning deductively from *a priori* assumptions, we should collect observations and examples from the world and form theories based on these observations.[2] This new emphasis on induction formed the basis of the scientific method and was largely responsible for the advances in the empirical sciences achieved during the Scientific Revolution. (See *The Argument Builder* for a more in-depth discussion of Francis Bacon and some of his contributions to inductive logic.)

The second reason later scholars did not continue to hold Aristotelian logic in high esteem was the abuse and limitations of Aristotle's logic. One limitation of Aristotle's logic was that he often accepted truths that appeared obvious from common sense that, in actuality, were false. For example, Aristotle had proposed the idea that heavier objects would fall faster than lighter objects based on "common sense" observation. As later scientists, such as Galileo, proved, this was not true. Suddenly, Aristotle's process of arriving at new truths through deduction from *a priori* beliefs appeared to be, at least occasionally, unreliable. Therefore, later scholars, especially in the University of Paris, began to doubt that Aristotelian logic was the "last word" in the field of logic. They began to react to the view that Aristotelian logic was like a gospel truth that could not be questioned. They realized that regarding Aristotelian logic as the best form of logic could prevent scholars from adding new perspectives and fashioning new logical tools, thus limiting advances in science and philosophy. As a result,

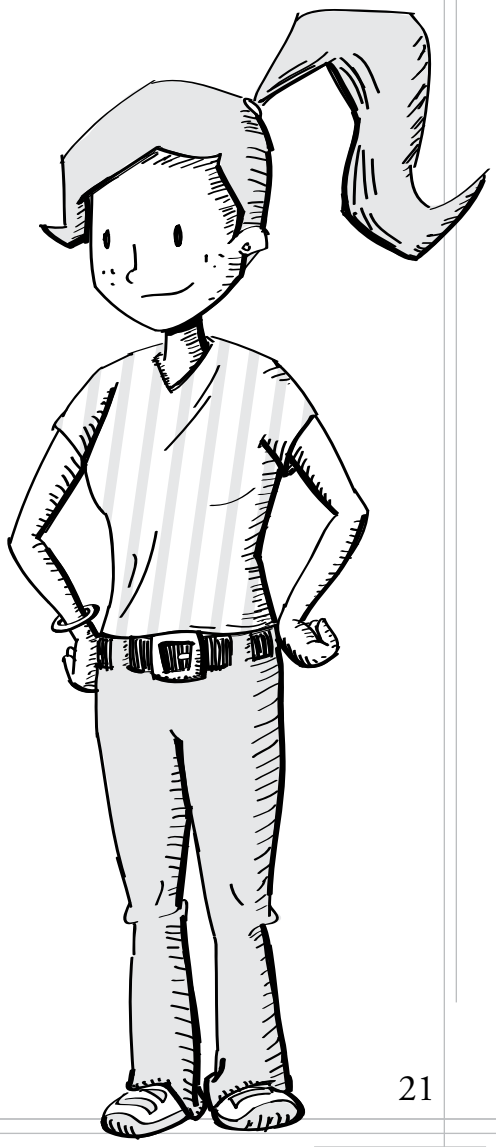
Aristotelian logic continued to be taught as a required subject in European universities well into the nineteenth century, but it had lost its status as *the* primary tool of serious scholarship.[3]

As the nineteenth century continued, philosophers and especially mathematicians took a second look at deductive logic and began to develop it in various ways, particularly in the area of propositional logic. For instance, George Boole (1815-1864) developed a system of symbolic logic known as Boolean logic. One of the strengths of Boolean logic was that it provided a logical framework for dealing with arguments or propositions about categories of things that didn't actually exist or that were hypothetical possibilities, such as unicorns or ghosts.[4] This was in contrast to Aristotle's logic, which had focused on propositions about things that *did* exist. Boole also developed a logical system that applied to math, which became known as Boolean algebra, and he and other logicians increasingly applied logic to math. Later scholars began to apply logic to computer systems.[5] Another influential philosopher, John Stuart Mill, explored rules that could help scientists determine cause-and-effect relationships. Cause-and-effect relationships are especially important in many scientific, medical, social, and psychological sciences. For instance, when doctors attempt to discover the catalysts (causes) for diseases like cancer and diabetes, they are studying cause-and-effect relationships. Mill's methods are still studied in modern college logic textbooks, especially in deductive reasoning texts.

These new topics of study in logic were certainly helpful. However, logic increasingly became an isolated, abstract, and specialized "science," rather than an "art" to be studied and used as a tool by all educated people. Perhaps this was partially responsible for logic's slow disappearance from the list of required courses in universities over the next century. It just didn't seem practical for the everyday person anymore. Logic either became an arcane subject that few students ever encountered, or it was repackaged as "critical thinking," which tended to focus more on lists of types of bad arguments. Although the study of critical thinking and the study of bad arguments (also called fallacies) is extremely helpful, people can gain an overly narrow view of logic if they only study fallacies and neglect the useful aspects of a traditional study of deductive logic.

This approach lasted until the 1970s when, partially as a result of the emergence of classical schools and classical curricula, there was a revival of the idea that all thinking people needed to understand the basics of logic as a tool for life.[6] Today, this movement continues and is expanding. As the movement grows, many people are rediscovering the benefits of Aristotelian logic, in conjunction with other types of logic, for clarifying and strengthening thinking.

As you continue your study of logic, it is important to realize that although categorical logic has some limitations, just as all types of logic do, it has helped people in the past to discover and formulate some of the most profound philosophical and scientific truths of our world. Furthermore, this logic still forms the foundation of many fields of study today, such as philosophy and ethics. Learning to use logic well will allow you to strengthen your own thinking and become an effective seeker of truth.



ANSWER

1. What were the two reasons why Aristotelian logic gradually became less dominant after the Middle Ages?

One reason Aristotelian logic gradually became less dominant after the Middle Ages was because Francis Bacon emphasized the importance of forming hypotheses from observing everyday life, rather than relying on *a priori* assumptions. The second reason was that, especially in the later 1900s, logic was increasingly influenced by the fields of mathematics and technology. During this time, logic followed a more abstract and symbolic path, rather than the earlier path established by Aristotle.

2. Name two of the modern thinkers (people who lived after the Middle Ages) mentioned in this lesson and summarize their contributions to the field of logic.

a. Three possible answers:

Francis Bacon: He placed a strong emphasis on inductive logic based on empirical observation of the world, rather than reliance on *a priori* assumptions.

George Boole: He further improved upon Aristotle's system of logic so that it could be used in discussions about categories of things that don't actually exist, such as unicorns and mermaids.

b. John Stuart Mill: He developed rules to help people determine correct causal relationships.

DEDUCTION IN ACTION

Thinking About Logic

Note to Teacher: For answers see page 326.

Throughout this book, as you encounter more Deduction in Action exercises, you will notice that some of them will help you to understand how logic is used in different areas of life, while others will aid you in analyzing other people's arguments. Still other times, the Deduction in Action exercises will ask you to develop your own arguments. Especially at the beginning of the book, don't be too concerned about how good your argument is or if it is structured properly. After all, you have just started learning about logic. At the beginning, focus primarily on putting your thoughts into words. Later, we will help you make sure that your argument is thoroughly developed and properly structured.

Consider this question: Why is it important for you to learn logic? As you will soon learn, all arguments have two main parts: a **conclusion**, which is the point you are proving, and a **premise**, which is the reasoning behind the conclusion. On a separate piece of paper, write a short argument with a premise and conclusion explaining why it is important for you to learn logic. Your conclusion will be this: "It is important for me to learn logic." Your premise should be a specific reason that supports this conclusion. Make sure that your premise is specific and different from the conclusion. For example, you want to avoid arguments like this: "It is important for me to learn logic because logic is a good skill to have." This supporting premise is weak, vague, and unhelpful. The more specific your premise is, the more helpful it will be.

Dialogue 3.1

Thinking About Thinking

The Nature of Formal Logic

Nate is going for a walk in the wooded outskirts of a college campus when he runs across his friend, Socrates, sitting under a tree.

Nate: Good morning! What are you up to today?

Socrates: Well, I was thinking.

Nate: I might have guessed. What were you thinking about?

Socrates: Actually, I was thinking about thinking.

Nate: *(as he sits down)* Now you're just being evasive. In what way were you thinking about thinking?

Socrates: Actually, I was musing on the subject of formal logic. Remember how I taught you and Tiffany* some informal logic? Do you know what the difference is between formal and informal logic?

Nate: Hmm. . . . I guess if you just go by the terminology, you might come to the conclusion that formal logic is where you evaluate the *form* of an argument, and informal logic is where you judge it by other criteria.

Socrates: If you were to draw such a conclusion from the terminology, then you would be on the right track. Let's think a little bit more about what I taught you in our discussions about informal logic. What standards did we use to evaluate recommendations?

Nate: We used the standards of **relevance**, **presumption**, and **clarity**.

Socrates: Absolutely. What were we doing with those standards?

Nate: We were judging arguments.

Socrates: That is what we were doing, for the most part, but remember that the same standards can be used for evaluating explanations and rhetorical tricks.

Nate: Refresh my memory. What is the difference between an **argument** and an **explanation**?

Socrates: While I admit that we philosopher types tend to use those two words in a very specific way, it's not really so far removed from how most people use them. Think about it. If I said that a friend of yours was trying to "argue for" something, what would you assume he was trying to do?

Nate: I would guess that he was trying to convince others to agree with him.

Socrates: You would be guessing correctly. How would he go about trying to convince them?

Nate: He would give them reasons to believe whatever it is.

***Note to Teacher:** Tiffany is Nate's college friend. Both Nate and Tiffany were recurring characters, along with Socrates, in Classical Academic Press's first logic book, *The Art of Argument*. In that book, Socrates taught them informal fallacies. Both Nate and Tiffany will appear in this book. Nate will appear in the dialogues with Socrates, and Tiffany will show up in other dialogues in the book.

Socrates: Exactly. He would be making an argument by supporting his **thesis**, or main point, with logical evidence. Now, what if your friend did something that you didn't agree was right, and you were trying to explain his actions? What would you be doing then? Would you be trying to convince yourself that what he did was right, even though you didn't agree with what he did?

Nate: No, not necessarily. You have to make a distinction between *explaining* something and *justifying* it.

Socrates: Why?

Nate: Well, if you were not able to try to understand something without justifying it, it would be hard to make much sense out of anything. For example, if you couldn't keep straight in your mind the difference between an explanation and a justification, you couldn't seek to understand the Mongol invasions without becoming a big fan of Genghis Khan. I guess that's the big difference between an argument and an explanation: An argument is trying to get you to agree with something, whereas an explanation is just trying to help you to understand it.

Socrates: Quite so. Remember also that an argument goes from premise to conclusion, whereas an explanation usually goes from **cause** to **effect**.

Nate: Ah, yes, I remember. Now that we've reviewed, let's get back to this formal logic stuff. In our discussions of informal logic, we mentioned that it is about evaluating arguments, explanations, and rhetorical tricks, and that you do so through the three guidelines of relevance, presumption, and clarity. So how is formal logic different?

Socrates: Well, I mentioned that formal logic is basically thinking about thinking. You could say that informal logic is about weighing, evaluating, and critiquing specific arguments and explanations. Formal logic, on the other hand, tries to break down and understand the process of thinking that people use when they create any argument or explanation. To put it in a nutshell, informal logic is "dialectical" in nature, whereas formal logic is "**structural**."

Nate: Whoa! That's a pretty large nutshell you're using. Please explain what you mean by that.

Socrates: By "dialectical" I mean that informal logic is about the back-and-forth, the ebb-and-flow of argument between people. By "structural" I mean that formal logic is about the process that an individual goes through as he begins to reason from one statement or proposition to another.

Nate: So, informal logic is about evaluating other people's arguments, and formal logic is about your own arguments?

Socrates: Well, that might often be true, but you can also be dialectical with yourself and your own arguments.

Nate: Huh? How can there be a "back-and-forth" or an "ebb-and-flow" when you're the only person in the room?

Socrates: Oh, come, now. Haven't you ever conversed with yourself?

Nate: Well, I don't like to admit it, but yes, sometimes I do. I'd hate to have people think I'm crazy or something, though!

Socrates: There's no need to be ashamed of it. After all, being able to dialogue with oneself, to weigh and critique one's own reasoning as you go along, is a part of what it means to be a person. While the dialectical aspect of informal logic usually involves other people, the important thing to remember is that it is all about weighing, evaluating, and critiquing the results of that reasoning. Formal logic is "structural" because it is more about how the process of good thinking works.

Nate: So then, informal logic is all about making arguments about the results of reasoning, whereas formal logic is more concerned with making explanations about how the process of good reasoning works.

Socrates: Ah, I like how your mind works. That's the basic idea. Informal logic is all about deciding whether or not you should accept or reject the

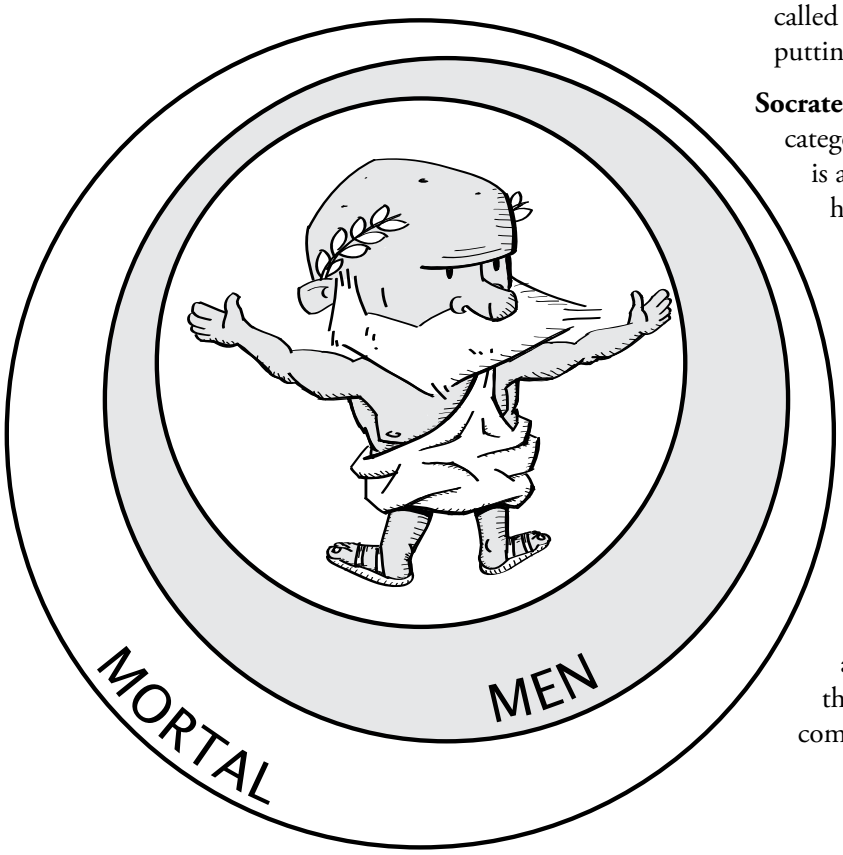
arguments made by others. It can also be about having that conversation with yourself as you attempt to determine whether the arguments and explanations are fair and make good sense. What we do in formal logic is quite different. In formal logic, we break the process of reasoning apart and make sense of the process itself. Informal logic is all about "real-world application," whereas formal logic is about understanding the theory behind reasoning. It's thinking about thinking!

Nate: So what are you thinking about thinking right now?

Socrates: Well, I was just musing over the system of formal logic created by the student of a student of mine.

Nate: You mean Aristotle?

Socrates: Yes, very good. Aristotle was the founder of formal logic. He created a very useful way to understand how the process of thought works based on three **acts of the mind**, which are **simple apprehension**, **judgment**, and **inference**.



Nate: That sounds kind of interesting. How does this system work?

Socrates: Well, let's take the three acts of the mind one at a time. Let's start with simple apprehension. When you say you "apprehend" something, what is going on in your mind?

Nate: Well, to be honest, I don't use that word too often. But, if I were to say such a thing, I suppose that would mean that I "sense" it.

Socrates: Yes, but there's more to it than that. After you sense that thing, you put it into some sort of category. For example, if you were to see a dog, you would see a four-legged, furry creature with (most likely) big, floppy ears. Then you would mentally put it into a category of things that you identify as dogs. That is a process we call **abstraction**. First you see something, then you pull out a category that seems to fit it, and finally, you mentally put that thing that you see into a category. Do you follow?

Nate: I think so. Hey, is that why deductive logic is called categorical logic? Is it because it works by putting things into categories?

Socrates: That's one reason. There are other categories in this type of logic as well, but that is a conversation for another day. Let's see how the process continues once we have put things into categories. Once you apprehend something, it can become the first building block for logic: a term. You then put together terms to form propositions. That process is called judgment. Then you move from propositions that you do know to ones that you don't know. That process is called inference.

Nate: Whoa! Slow down!

Socrates: OK. I guess the best way for me to explain this is for me to give you an argument and then break it down into those three layers for you. Let's start with a very commonly used argument.

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

Nate: That argument sounds kind of familiar.

Socrates: I'm not surprised. It seems like every logic textbook and every logic teacher starts right off with an argument about my being mortal. It's a bit unsettling to constantly be reminded of my mortality. Anyway, that argument fits into a pattern that we refer to as a **syllogism**, a special kind of three-statement deductive argument. Each of those statements is what we call a proposition. Each of those propositions takes two terms and shows how they relate to each other.

Nate: So, you would first apprehend the two terms "men" and "mortal" and then show how they relate to each other by saying that "all men are mortal"?

Socrates: Exactly. When you show how two terms relate to each other, that act of the mind is called judgment. As we noted, the result of that act is called a statement or a proposition. Now, when you then move on from the statements "All men are mortal" and "Socrates is a man" and decide on the basis of those two statements that, therefore, "Socrates is mortal," then what have you done?

Nate: Well, you have figured out something that you didn't know on the basis of something that you already did know.

Socrates: In theory. I'm sure that you were not at all ignorant of my mortality beforehand. What you certainly have done, though, is show that if you were to accept the first two propositions, then the last one must follow. The mental act of drawing conclusions on the basis of what you already know (or at least assume) is referred to as the **process of inference**. In this case, it is what we refer to as a **deductive inference** because this is a deductive argument.

Nate: So, you could also do something similar to make an inference from an inductive argument, and it would be called an **inductive inference**?

Socrates: Exactly. You could also use a process of inductive inference to make inductive explanations. However, inductive inference works very differently from deductive inference. In inductive inference, we take propositions that we gather from our observations of the world around us and use them to make "educated guesses" about things we haven't observed yet.

Nate: Educated guesses? That sounds kind of chancy.

Socrates: It is, actually, but some inductive arguments and explanations are very reliable. It all has to do with just how much evidence you can bring to bear on the problem. Unlike deductive arguments, however, the premises of an inductive argument will never make the conclusion absolutely necessary. They will only make it more likely. A deductive argument, if properly formed, is said to be valid. In a valid deductive argument, if you accept the truth of the premises, the conclusion absolutely must be true as well. Inductive arguments aren't like that. Instead, they are said to be either strong or weak.

Nate: It sounds like it would be better to use a deductive argument, since it gives you more certainty.

Socrates: Perhaps so, but there are situations in which we don't really have a choice. There are many times in life when you simply need to draw a conclusion from the information that you have, and you may not be absolutely sure that it is the right conclusion. Such is the human condition, I guess. In any case, most logic teachers like to teach deductive inference before they tackle the complexities and "gray areas" of inductive reasoning. After all, the study of deductive inference was begun earlier—by Aristotle, if you recall—and it is a good foundation for all kinds of formal logic.

Nate: This is very interesting, but I must be getting to class now. I want to hear more about this stuff, and I do hope to see you again soon.

Socrates: You can count on it, my friend!

EXPLAIN

1. Explain the differences between formal and informal logic or reasoning.

Formal logic pertains to the structure or form of an argument. Informal logic pertains to the application of the logic. In addition, formal logic often applies to a person's analysis of his own thoughts, whereas informal logic often applies to the logic in a discussion between two people.

2. Explain the differences between a logical argument and an explanation.

An explanation offers reasons or illustrations for why something is so. An argument makes a case for or against something.

3. Explain how people use the three acts of the mind when they make arguments.

When people make arguments, they engage in three mental acts. The first is simple apprehension. This occurs when someone recognizes, identifies, or classifies something, such as a chair, a president, or the idea of love. The next mental act is judgment. This occurs when someone unites two objects or concepts. For example, when someone makes the judgment that "love is the greatest virtue," she unites the concepts "love" and "virtue." The last mental act is inference. When someone makes an inference, he uses judgments he knows are true to arrive at further judgments. For example, someone might have the judgments "All triangles have angles that equal 180 degrees" and "An isosceles triangle is a triangle." He could then make the inference "An isosceles triangle has angles equaling 180 degrees."

EXPLAIN (CONTINUED)

4. Explain why deductive arguments are referred to as valid or invalid, whereas inductive arguments are referred to as strong or weak.

Deductive logic pertains to the structure of an argument, and the structure of an argument is either correct or incorrect. There is no gray area with deductive arguments. Therefore, the word "valid" means that a deductive argument is structured correctly, whereas the word "invalid" means that it is structured incorrectly. Inductive logic pertains more to the actual content of an argument and the weight of evidence involved. Inductive arguments are based on generalization, and no generalization has a 100 percent guarantee of accuracy. Therefore, inductive arguments are considered to be either strong or weak, rather than valid or invalid.

DEFINE

1. Three Acts of the Mind:

a. Simple Apprehension: Simple apprehension is the recognition and naming or classification of an object or concept.

b. Judgment: Judgment is a thinking process that occurs when a person expresses a relationship between two terms.

c. Inference: Inference is a reasoning process through which a person arrives at new information through the implications of other axioms, postulates, or observed examples.

2. Syllogism:

A syllogism is a deductive formal argument consisting of two premises followed by a conclusion.

3. Inductive Inference:

Inductive inference is a reasoning process that occurs when someone arrives at a general conclusion or hypothesis based on observations of patterns in a group of examples.

Lesson 3.2
The Three Acts of the Mind

Points to Remember

1. The three basic building blocks of categorical logic are: 1) the term; 2) the proposition; and 3) the argument.
2. The three acts of the mind are: 1) simple apprehension; 2) judgments; and 3) inferences.
3. Simple apprehension occurs when we put things into groups, classes, or categories in our minds.
4. When we think about a relationship between two terms, we make a judgment.
5. We make an inference when, after making one or more judgment propositions, we conclude that yet another proposition necessarily follows from the first ones.

> Never be afraid to sit awhile and think.
> —Lorraine Hansberry[1]

Aristotle, who first organized traditional categorical logic, looked at the subject as you would if you were using blocks to build a structure. He distinguished three basic building blocks in categorical logic and called them terms, propositions, and arguments. They were based on his philosophy of how we reason. He believed that people reason using three acts of the mind, which he named simple apprehension, judgments, and inferences. Through simple apprehension we produce terms, through judgments we produce propositions, and through inferences we produce arguments.

Simple Apprehension

Simple apprehension occurs when we put things into groups, classes, or categories in our minds. We usually do this automatically, without really thinking about it when we are doing it. In other words, simple apprehension seems to come naturally to us as thinking human beings. So, for example, when we see a motorized vehicle with four wheels coming down the road, we automatically think "car." Or, when we see a flying bird land on a pond and swim, we think "duck." We mentally place these things into a group or class of similar things with which we are familiar. Only when we see new things with which we are unfamiliar do we actually think about how they should be categorized. Notice that we always have the impulse to categorize things whether or not we are familiar or unfamiliar with them. When we engage in simple apprehension, it results in our naming the category or class to which something we have apprehended belongs. In categorical logic, the mental category in which we place something is called a term, which is a word or phrase that represents a class of related things.

Judgment

When we think about a relationship between two terms, we make a judgment. For example, if we think about the relationship between the terms "frogs" and "animals," we might think that all frogs are animals. In the world of categorical logic, the relationships we are usually interested in are ones of **class inclusion**. That is, one class, or some members of that class, are included within another class. Subsequently, we think the "frogs" class is included in the "animals" class, but not the opposite, because not all animals are frogs, right? Let's look at another example. When we say, "Socrates is a man," we are really saying that the class of things known as "Socrates" (and he's in a class all by himself) is included within the class of things we refer to as "men."

There are some other types of relationships between terms that we apprehend through the act of judgment, which we will examine a little later. Notice that when we think or speak of the relationship between two terms, we do so in the form of a proposition, such as "All frogs are animals" or "Socrates is a man."

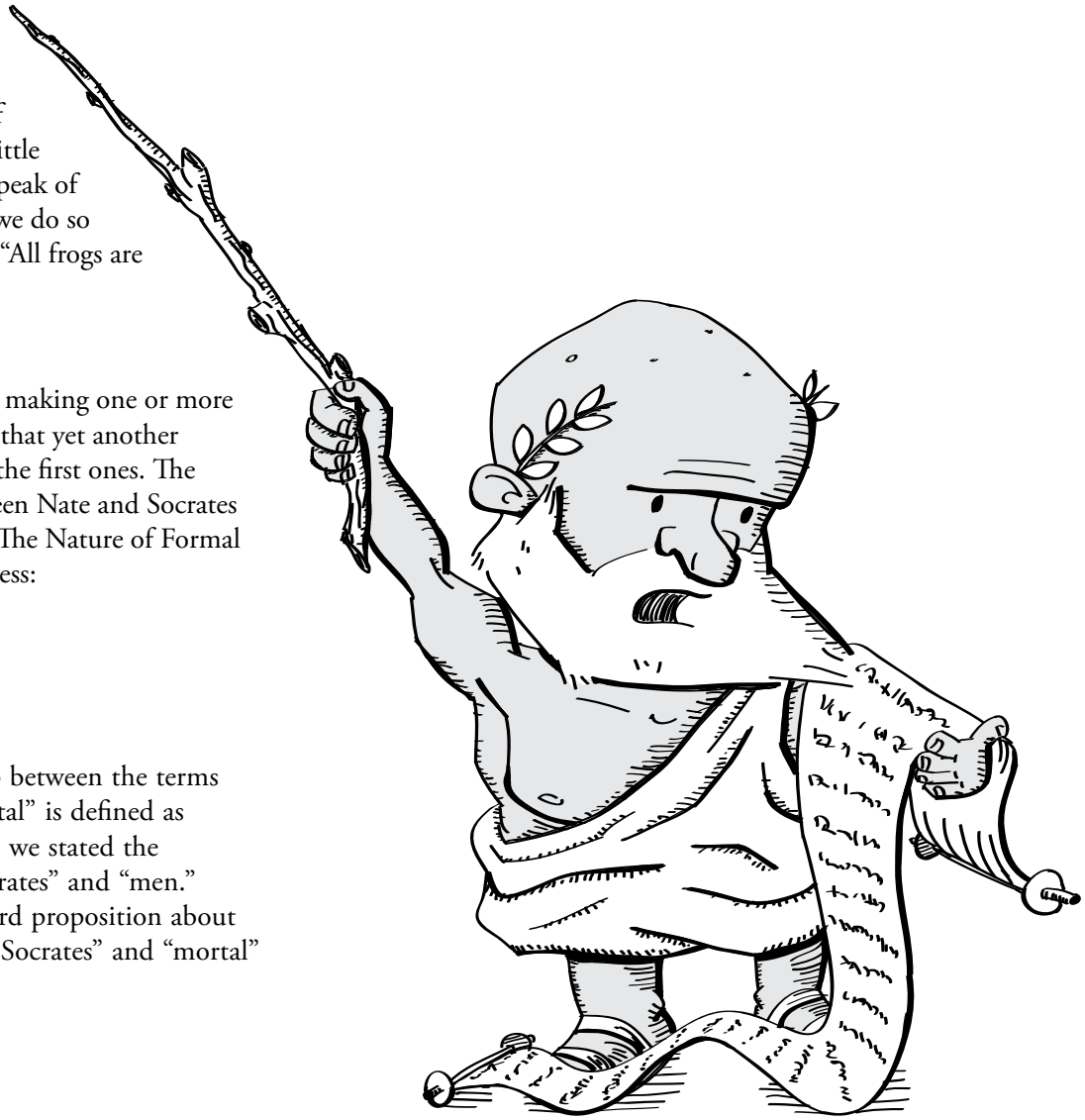
Inference

We make an inference when, after making one or more judgment propositions, we conclude that yet another proposition necessarily follows from the first ones. The syllogism given in the dialogue between Nate and Socrates entitled "Thinking About Thinking: The Nature of Formal Logic" is a good example of this process:

> All men are mortal.
>
> Socrates is a man.
>
> Therefore, Socrates is mortal.

Here we first stated a relationship between the terms "men" and "mortal." The term "mortal" is defined as a class of things that must die. Then we stated the relationship between the terms "Socrates" and "men." After doing so, we can see that a third proposition about the relationship between the terms "Socrates" and "mortal" necessarily follows from the first two. In other words, if the first two propositions are true, the third proposition also has to be true.

In the next couple of chapters, we will look more closely at each step of the thought process in order to be able to accomplish the end step, which is building arguments more effectively.



Define

1. Simple Apprehension:

Simple apprehension is the mental act of putting things into categories.

2. Judgment:

Judgment is a thinking process that occurs when a person expresses a relationship between two terms.

3. Inference:

Inference is a reasoning process through which a person arrives at new information through the implications of other axioms, postulates, or observed examples.

Explain

Now that you have read about the three mental acts, it's time that you saw an example of them in real life. Read the story below and then complete the following activity.

> Elena was walking through the woods one day, when she noticed a beautiful plant with small red globes on it. She was very hungry, so she stepped forward eagerly, hoping she might be able to eat part of the plant. However, as she stepped forward, she recognized the globes on the bush as berries. She thought to herself, "These globes are the poisonous berries I've read about in my botany book." Then she thought, "Poisonous berries can make people extremely sick or even kill them. Obviously, I don't want that to happen, so I don't care how hungry I am, I'm not eating the berries."

In the space below, explain at which point Elena makes a simple apprehension, a judgment, and then an inference. Remember, these three items should all be related in that they are part of an argument she is making to herself.

1. Simple Apprehension:

Elena makes a simple apprehension when she recognizes the globes as berries.

2. Judgment:

Elena makes a judgment when she says to herself, "These globes are the poisonous berries I've read about in my botany book."

3. Deductive Inference:

Elena makes a deductive inference when she says, "Poisonous berries can make people extremely sick or even kill them. Obviously, I don't want that to happen, so I don't care how hungry I am, I'm not eating the berries."

IDENTIFY

Here is a second story. Read the story and then identify at which part in the story simple apprehension, judgment, and inference occur.

> Andrew Pachek, who had recently read an article on bike safety, was riding his bike home from school one day, when he recognized a driveway up ahead with a car about to back out of it. He thought to himself, "Driveways with drivers backing out of them are dangerous to bikers because drivers don't always watch where they are going." Then he thought, "This could be dangerous. I'm going to watch carefully."

1. Simple Apprehension:

Andrew makes a simple apprehension when he recognizes a driveway with a driver pulling out of it.

2. Judgment:

Andrew makes a judgment when he says to himself, "Driveways with drivers backing out of them are dangerous to bikers because drivers don't always watch where they are going."

3. Inference:

Andrew makes an inference when he thinks, "This could be dangerous. I'm going to watch carefully."

MATCH

Match the act of the mind with that which results from it by drawing a line between them.

1. Simple Apprehension
2. Judgment:
3. Inference:

a. Proposition
b. Argument
c. Term

Deduction in Action

Logic and Personal Thoughts

If you use logic, one of its greatest personal benefits is the ability it gives you to examine and clarify your own personal thoughts, or your own mental acts. You might remember that part of Socrates' quote at the beginning of the first chapter was "The unexamined life is not worth living." One of the reasons it is so important to examine our own thoughts, or mental acts, is because doing so can save us from a lot of worry.

Let me illustrate this with an example that may be familiar to many of you. When I was in high school, I would often get extremely nervous after a test when I thought I had missed some of the problems or questions on it. My stomach would be in knots. This was usually because I was making some of the following judgments and inferences: "I didn't know some of the answers on the test. I must have failed the test. I will fail other tests. I'm going to fail school. I'm not going to be able to go to college. I'll never get a job. I'll be living on the streets!"

Now, of course, these thoughts look ridiculous when written out, but that's the point. When these thoughts were swimming around unidentified in my brain, they could cause a lot of unnecessary worry and anxiety. To combat this tendency of mine, my mom used to play the "What's the worst that could happen?" game with me. This was actually a way for me to confront my exaggerated judgments and inferences. For example, she would ask me, "What's the worst thing that can happen if you missed some items on the test?" Of course, I might have wanted to respond, "I'll fail school and become a homeless person," but I knew, as I was thinking it, that it was silly. So, I would usually say something like, "Well, I might fail the test, but more likely I might get a B or C."

Suddenly, things became much less dramatic and anxiety-producing. Then my mother would say, "What is the worst that could happen if you failed the test?" I would answer, avoiding unnecessary drama, "Well, I wouldn't like it, but I could ask the teacher for help, and if I had made some honest mistakes, he might let me take it over." With each "What's the worst . . ." question my mom asked me, she would force me to state my judgments and inferences (although she did not ever call them by those names and probably did not know that was what she was doing).

It's very hard for overly dramatic thoughts to hide in the plain light of day. This is one reason, I think, that Socrates continually urged people to examine their thoughts. Unexamined thoughts can hide in our brains, causing unnecessary drama or resulting in wrong beliefs or actions. Later on in this book, you will have a chance to read a dialogue in which Socrates tries to help a guy examine some of his seriously misguided thinking. For now, just pay a little more attention to your mental acts and see if you can make your life a little easier.

Stop the Drama

Try the "What's the worst thing that could happen?" game with your own thoughts. Take something that is really bothering you and ask yourself, "What's the worst thing that could happen?" for each of your fears. Make note below of any incorrect or overly dramatic judgments or inferences that you are making. If you have problems doing this with your own thoughts, ask someone to do it for you and to challenge you on your incorrect or overly dramatic judgments.

Note to Teacher: Answers will vary.

Deduction in Action

Answers

Lesson 1.1: Logic and Socratic Dialogue *(from page 5)*

1. What did the Delphic oracle reveal to Socrates?
   The Delphic oracle revealed to Socrates that there was no one wiser than he.

2. How did Socrates go about trying to prove the Delphic oracle wrong?
   Socrates tried to prove the oracle wrong by traveling around Greece and questioning people who were purported to be wise so that he could find someone wiser than he.

3. Why did Socrates' attempt to prove the oracle wrong anger some of his fellow citizens?
   His actions angered some of his fellow citizens because he discovered that all of the people purported to be wise, or who claimed to be wise, really weren't wise. He felt it was his duty to point this out to them, and they didn't like it.

4. What were the two charges brought against him?
   He was charged with corrupting the youth of Athens and encouraging them not to believe in the gods anymore.

5. When Socrates was found guilty, he made a joke about what his sentence should be. What did he say his sentence should be, and why did he say it should be that?
   He said that he should be given free meals because he had traveled around helping people gain wisdom at great cost to himself, since he had earned no money for his work, and it had required him to neglect his property and family.

6. Why, according to Socrates himself, could he not stop himself from doing what he was doing?
   Socrates said that he could not stop doing what he was doing because the god (this is what Socrates calls the god of Delphi, who he calls as a witness to his wisdom) had told him to do so.

Lesson 1.2: A Look at Philosophy *(from page 8)*

What *a priori* truth does Anaximander use to reach his new truth?

Anaximander states that humans originally had to come from some other animal than humans because baby humans cannot fend for themselves, and if the first human had been like humans are now, the first human never would have survived.

The *a priori* truths from which he reasons are these:

Infant humans cannot survive on their own.
The first human survived (because we are all here).

He reasons from these two *a priori* truths that the first human had to be different than today's humans because it wouldn't have survived if it was just like humans today since human infants can't survive on their own.

Lesson 1.3: Logic and the Movies

(from page 13)

From what you know about deductive logic so far, see if you can write the aforementioned argument (on page 13) in some semblance of a deductive argument (mind you, it's certainly a silly deductive argument). The "argument" begins when Sir Bedevere claims that there are ways of telling whether or not the woman is a witch.

We burn witches.

Therefore, anyone who can burn is a witch.

Wood also burns.

Wood also floats.

Ducks also float.

If something weighs as much as a duck, it weighs as much as wood.

If it weighs as much as wood, it will float like wood.

If it floats like wood, it burns like wood.

If it burns, it's a witch.

You can find a clip of this whole scene at the following website: <http://www.youtube.com/watch?v=zrzMhU_4m-g>.

Lesson 2.1: Think About It *(from page 19)*

1. Why is it important to be able to entertain an idea without accepting it?
   Answers will vary, but the following is a possible answer. It is important to be able to entertain ideas without accepting them because this allows you to look at both sides of an issue, which will help you to have a better argument.

2. Why is entertaining an idea without accepting it especially hard to do?
   This is especially hard to do because we tend to examine in-depth only arguments with which we agree. It is difficult to do this with arguments with which we do not agree because it forces us to consider the possibility of contradictory ideas. As humans, we often like to avoid difficult thinking.

Lesson 2.2: Thinking About Logic

(from page 22)

On a separate piece of paper, write a short argument with a premise and conclusion explaining why it is important for you to learn logic. Your conclusion will be this: "It is important for me to learn logic." Your premise should be a specific reason that supports this conclusion. Make sure that your premise is specific and different from the conclusion. For example, you want to avoid arguments like this: "It is important for me to learn logic because logic is a good skill to have." This supporting premise is weak, vague, and unhelpful. The more specific your premise is, the more helpful it will be.

As you well know, there are many different good reasons to study logic. Below are some of the most common reasons people give for studying the subject:

- It is important to study logic so that I can decide what is right to believe.
- It is important to study logic so that I can properly evaluate people's arguments.
- It is important to study logic so that I can avoid incorrect and distorted thinking.
- It is important to study logic so that I will be an effective thinker and problem solver.

Students may have other answers as well. The key of this exercise is to help them form specific premises. Be sure to review the students' answers and help them to refine any premises that are too general.

Lesson 4.2: Logic and Paradoxes

(from page 39)

Read the argument (the arrow paradox) and think about which of the propositions you might be able to critique or which of the words in the proposition might be used in an incorrect manner.

The following are the individual propositions that make up this paradox:

1. "The arrow could not move in the place in which it is not."
2. "Neither could it move in place where it is."
3. "For this is a place equal to itself."