A LOGIC PRIMER

A Little Logic

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Logic is the branch of philosophy that studies the relationship between the premises (or claims) and the conclusion of arguments and emphasizes finding objective criteria for assessing the logical quality of different kinds of argument.

ARGUMENTS

Arguments are the tools people use in rational persuasion. Arguments are one of the ways we make sense of the world. While you may not be familiar with the form of an argument, you have used arguments in your life. Whenever we want to convince someone to accept a position we consider correct, we present arguments in its favor. The construction, use, and analysis of arguments is a process of reasoning.

To make (or give) an argument is to make a claim about something and to offer other claims as reasons for accepting the claim. Technically, an argument is a claim that the truth (or value) of one claim depends on the truth (or value) of other claims; so an argument is an assertion or claim about relationships among assertions or claims. This allows us to define an argument as a set of
linked (related) statements that claim to support a conclusion. Argument is a form of reasoning.

Mere disagreements or conflicts are not arguments. This is not an argument.

1. Sam: Mary loves Carlos.
2. Ellen: No she doesn't.
3. Sam: Yes, she does!
4. Ellen: No she doesn't.

This is just a disagreement. It is not an argument because no reasons are given to support Sam's claim that "Mary loves Carlos" or contrarily to demonstrate that Mary does not love Carlos. Here is an argument.

Sam: Mary loves Carlos! They have become inseparable.

Ellen: That's not true. They are chemistry lab partners, you know.

Sam: Sure, but Carlos is all she talks about not chemistry! She spends as much time as she can with the guy and they are on the phone for hours at a time.

This is an argument. Sam makes a claim, "Mary loves Carlos," and offers reason to support claim ("They are inseparable"). Ellen disagrees and makes another claim ("Mary does not love Carlos") and offers evidence (reasons) to support it. Sam counters with additional reasons to support his claim.

Notice too as Sam and Ellen reason together they are claiming that there is a relationship between the reasons and the conclusion. When people reason, they make inferences. Inference involves a special relationship between different claims: when we infer B from A, we move from A to B because we believe that A supports or justifies or makes it reasonable to believe that B is true. For example, if I wish to know how many students are present in the classroom, I could simply count the number, but a quicker way to arrive at an answer is to infer it from what I know or think I know.

Suppose I believe the following: there are 100 seats in the classroom, every student present is seated, every seat but one is occupied, and no seat is occupied by more than one student. From this I infer that there are 99 students present. This inference may be set out formally as an argument, which we may define as a public expression in words, be it orally or in writing, of an
inference we make when we reason. The argument expressing the above inference may be written as follows:

1. There are 100 seats in the classroom.

2. Every student present is seated.

3. Every seat but one is occupied.

4. No seat is occupied by more than one student.

5. Therefore, there are 99 student in the classroom.

The supporting claims 1 to 4 are called the premises of the argument, and the claim which is alleged to be supported by the premises, in this case statement 5, is called the conclusion of the argument.

The evaluation of an argument involves two considerations:

(i) the assessment of the truth of its premises, and

(ii) the assessment of the connection or relationship between the premises and the conclusion.

Note in order to judge how strong or successful an argument is, both assessments, truth and connection, must be made. Here are example of each kind of assessment:
Premises and conclusion are properly related, but one or more premises are false

A. 1. All jazz musicians drive Hondas.

2. Loretta Lynn is a jazz musician.

3. Therefore, Lorette Lynn drives a Honda.

B.1. 95% of dentists plays the tuba.

2. Billy Joel is a dentist.

3. Therefore, Billy Joel plays the tuba.

Premises are all true, but the premises and conclusion are not properly related:

C.1. All senators are politicians.

2. Bill Clinton is a politician.

3. Therefore, Bill Clinton is a senator.

D.1. A few scientists are geniuses.

2. Einstein was a scientist.

3. Therefore, Einstein was a genius.

None of the above arguments justifies (verifies, supports, shows as reasonable) its conclusion. Note, however, that this failure does not mean that the conclusions are shown to be false. Indeed, the conclusion of D is true, and those of A, B and C are false, but the argument does not show this. Another argument might be devised to show it, such as:

E. 1. No member of the Senate is President of the U.S.

2. Bill Clinton is President of the United States.

3. Therefore, Bill Clinton is not a senator.

This argument does justify its conclusion, because its premises are all true, and the premise and conclusion are properly related.

Whether the premises of an argument are true is not the job of logic. The concern of logic is with the relationship between premises and conclusions in an argument. What logic asks is: assuming the premises of this argument are true, would this argument justify the conclusion? Do these premises provide good reason for accepting the conclusion?

However, an evaluation of the truth or falsehood of claims is part of the job of sound reasoning. Evaluating the logical form of an argument and assessing the truth of the claims of an argument are complementary tasks.

For example, if I make the claims "Alan is unhappy" and "Anna was in a car accident" I can assess the truth or falsehood of these claims by weighing the evidence. To discover the truth of falsity of claims we examine the claim and look for the evidence that will show us whether it is true or false.

But suppose I make this claim: "Alan is unhappy because Anna had a car accident." Now, I am not just claiming that the statements "Alan is unhappy" and "Anna had a car accident are true. I am also claiming that there is a relationship between Alan's unhappiness and Anna's accident. The relationship between the two claims must also be evaluated. Each claims separately can be
true, but what is in question in the argument is the claim that there is a relationship between the two claims such that one (the premise, "Anna had an accident last night") supports (justifies) the conclusion ("Alan is unhappy")

Logical Strength

Since an argument always includes a claim that its premises support its conclusion, assessing (or evaluating) an argument means assessing this claim. Do the premises really support the conclusion, and if so, how much support do they provide? In other words, how strong is the argument? We can say that an argument has logical strength when its premises, if they are true, provide support for its conclusion.

Before we move on there are two features of logical strength which must be stressed.

First, the logical strength of an argument is independent of the truth or falsity of its premises: we do not need to know that the premises of an argument are true in order to assess its logical strength.

Consider this argument:

1. The population of San Antonio is one million.

2. The population of Austin is 500,000.

3. Therefore, San Antonio is larger than Austin.

Even if we do not know the populations of San Antonio or Austin we can still see that the argument is a strong one.

If both premises are true then, obviously, the conclusion must be true. The fact that either or both of the premises might be false does not affect the logical strength of the argument. Thus, an argument may have logical strength and false premises. In the same way, an argument may have true premises and not have logical strength if the premises do not provide support for the conclusion. Either way the argument is a bad or unsound argument.

Second, the logical strength of an argument is often a matter of degree. Some arguments are so strong that the truth of the premises guarantees the truth of the conclusion. But other arguments have premises which only make the truth of the conclusion more likely true than false.

Here is an argument whose strength guarantees the truth of the conclusion.

1. All human beings are mortal.

2. Socrates is a human being

3. Therefore, Socrates is mortal.

Here is an argument whose strength only makes the conclusion likely not certain.

1. Mary spends all the time she can with Carlos.

2. She phones him everyday.

3. She thinks about him often.

4. She sighs when his name is mentioned

5. Therefore, Mary is in love with Carlos.

To understand the notion of logical strength lets go back to our arguments A-E.

Arguments A and E above are ones in which, if the premises are all true, the conclusion MUST BE true. It is impossible for the premises to be true and the conclusion false. Such arguments are called valid arguments. We shall also refer to them as deductive arguments. A valid deductive argument is one in which the conclusion cannot be false if the premises are true. Hence a valid
argument, all of whose premises are true, must have a true conclusion. Such an argument is called sound. A sound argument is one which has both logical strength and true premises. Of the above arguments, only E is sound. Here is another example of a sound argument:

F. 1. Only citizens of the United States are eligible to vote in American elections.

2. John Major [the Prime Minister of Great Britain] is not an American citizen.

3. Therefore, John Major is not eligible to vote in American elections.

Argument B is not valid, because its premises could all be true and its conclusion false. This, however, does not mean that the premises, if true, do not provide good reason for accepting the conclusion. If the premises of B are true, then the conclusion is very likely or probably true. An argument which is such that its premises, if true, render its conclusions probable (more likely true than false), is an inductive argument. Rather than saying an inductive argument is valid we will say that it is successful or cogent.

Arguments C and D, like B, are not valid. However, in neither C nor D do the premises provide good reason for accepting the conclusion (most politicians are not senators, and most scientists are not geniuses). The conclusions of C and D are not probable given the truth of the premises. Such arguments are called fallacious. A fallacious argument is one which lacks logical strength;
that is which fails to provide adequate support for its conclusion.

Understanding the concept of logical strength is the key to developing critical thinking skills. The fact that the logical strength of an argument is independent of the truth of its premises means that in order to assess an argument we must do more than merely determine whether its premises are true. The fact that logical strength is a matter of degree means that we must also be sensitive
to the various elements of arguments that affect its degree of strength. If we lack these skills we can easily be fooled into thinking that an argument is strong when the premises actually supply little or no support for the conclusion.

To review:

Use of language and reasoning about things

Up to now we have been considering language as a way we makes claims about or describe what is the case or what is valuable. However, we use language in ways other than to express truth.

We use language for a wide variety of purposes. Sometimes we ask questions, sometimes we give commands, and sometimes we describe things. We use different kinds of sentences for these purposes.

To ask questions we use interrogative sentences, such as

1. What time is it?

2. Did you feed the dog? .

3. I won't give you the money, until I know why.

To give commands we use imperative sentences, such as

4. Tell me the time!

5. Feed the dog!

To describe things we use declarative sentence, such as

6. It is 5:00 o'clock.

7. I fed the dog.

Declarative sentences can be about all sorts of things. They can describe relatively minor points and they can describe major events. Declarative sentences can be about things that are easy to observe and check, and they can be about things that are difficult to know about.

All the following sentences are declarative:

8. Richard Nixon resigned from the presidency in 1974

9. George Bush does not like to eat broccoli.

10. There are more than 100,000,000,000 insects in the world.

Declarative sentences are the only ones that can be true or false. It wouldn't make any sense to respond to a command or a questions by saying "That is true" or "That is false." Such responses would only make sense when a claim is made, when we declare that something is or is not the case as in premises 8-10.

When we make arguments, we almost always use declarative sentences. You can't argue for a question or command, but you can argue for the truth of an declarative sentence. You can't prove that something is true by asking a question or giving a command, but you can describe some facts in an effort to argue for a conclusion. So, declarative sentences are always used to express the conclusion and premises of arguments.

To review:

You must be able to readily identify types of sentences as a foundation for understanding arguments and developing clarity of thinking.

Recognizing Arguments

Arguments may be short or long. For example, this is an argument:

She is armed, so she is dangerous.

In standard form the argument looks like this:

1. She is armed.

2. Armed people are dangerous (implied, unstated)

3. (Therefore), she is dangerous.

Length then is no indication that someone has made an argument. What determines if an argument has been made is the presence or absence of inferences. Consider the following pairs of sentences.

Alan is broke, and he is unhappy.

Alan is broke, therefore, he is unhappy.

Anna was in a car accident last week, and she deserves an extension on her class essay.

Anna was in a car accident last week, so she deserves an extension on her class essay.

This triangle has equal sides and equal angles.

This triangle has equal sides; hence it has equal angles.

Notice that the first sentence in each pair only asserts two thoughts but it says nothing about any relationship between them; while the second sentence in each pair asserts a relationship between the two thoughts. This relationship is indicated by the words therefore, so, and hence. These are called inference indicators words that indicate that one thought (or claim) is intended to support (justify, provide reason for, provide evidence for, or entail) another thought (claim). The presence of absence of inference indicators provide a strong, but not necessary, indication that the speaker/writer is making an argument.

But sometimes the inference indicator is missing, usually because the inference is obvious. Consider this example:

It is raining. I better take my umbrella to work today.

The obvious inference is "If (or when) it rains, I ought to take my umbrella.

Here are a few clues to help you identify arguments in context.

Locating conclusions

Conclusions are the positions people take on issues. Conclusions make claims, state viewpoints, offer opinions, and take stands.

How can we locate the conclusion of an argument? Try the following methods when you have trouble finding the conclusions:

1. Find the issue and ask yourself what position the writer or speaker is taking.

2. Look at the beginning, or ending of a paragraph or an essay; the conclusion is often found in one of these places.

3. Look for conclusion indicator words: therefore, so, thus, hence. Also look for indicator phrases: my point is, what I am saying is, what I believe is. Some indicator words and phrases are selected to imply that the conclusion drawn is the right one. These include: obviously, it is evident that, there is no doubt (or question) that, certainly, and of course.

4. Ask yourself, "What is being claims by this writer or speaker?"

5. Look at the title of an essay, sometimes the conclusion is contained within the title. For example, an essay might be called "Why I believe vitamins are essential to health."

Supporting conclusions

Reasons are the statements that provide support for conclusions. Without reasons, you have no argument. You simply have a statement of someone's opinion.

Reasons are also called evidence, premises, support, or justification. In critical thinking the vast amount of time and effort is spent looking at the quality of reasons use to support a conclusion.

Here are a few ways to locate the premises (reasons) in an argument.
1. Find the conclusion (see above) and then apply the "because" trick. The writer or speaker believes (claims, argues)
______________ (conclusion) because _____________________. The reasons will naturally follow the word because.

2. Look for other indicator words that are similar to because such as since, for, first, second, third, as evidenced by, also, furthermore, in addition.

3. Look for evidence that supports the conclusion. This support can be in the form of examples, statistics, analogies,

reports of studies and expert testimony.

Evaluating Arguments

The challenge of argumentation is to meet an argument on its own terms. That is, to evaluate it as an argument. What this means is avoiding the temptation to judge arguments only in terms of whether we agree or disagree with the conclusion. Someone who offers an argument is offering reasons to support a case, and we should respond on that basis. If we do not wish to accept the conclusion, we should nevertheless work through the argument to find out where and why we disagree with it. Are the premises wrong? Is the reasoning unacceptable or fallacious? Do the reasons fail to support the conclusion?

A sound argument is one in which the premises (if true) entail the conclusion. An argument must be evaluated in terms of the validity of the argument (the connection between the premises and the conclusion) and the truth of the premises. An argument which is valid and which has true premises is said to be sound or cogent.

A very simple test of sound arguments are the ARA conditions. A sound argument must have (A)ccptable premises that are (R)relevant to the conclusion, and provide (A)dequate grounds for accepting the argument.

Acceptable premises The premises of an argument are acceptable provided there is appropriate evidence, or reasons, to affirm their claims (or in popular language to believe them).

Relevant premises. The premises of an argument are relevant to its conclusion provided they give at least some evidence, or reasons, in favor of the conclusion.

Adequate grounds. The premises of an argument are adequate provided the premises are sufficient to provide good reasons or full evidence for the conclusions. Premises offer sufficient grounds if, assuming that they are accepted, it would be reasonable to accept the conclusion.

An argument can fail on any of these grounds.
If one or more premises are unacceptable, then the argument is not sound. We ought to reject it.
If the premises are not relevant to the conclusion, then the argument is not sound. We ought to reject it.
If the premises do not provide an adequate basis fort he conclusion that is drawn, then it is not sound. We ought to reject.

The ARA conditions are three important criteria to use to assess our own arguments and the arguments of others.

Validity and Deductive Reasoning

We have defined critical thinking as thinking that attempts to arrive at a conclusion through honestly evaluating a position and, whenever possible, its alternatives, with respect to the available evidence and arguments. We further identified three major steps in that process: clarification and understanding, evaluation, and expressing the results of judgement. Throughout, we have learned some techniques to help in clarifying and understanding an issue. One of those techniques was how to identify arguments and to distinguish them from statements of mere opinion. Once we have identified an argument, we must begin the step of evaluating it.

Because not all arguments are good, we must develop ways to distinguish those that are from those that are not. To do this, we need to address a few basic questions. First, we must ask whether or not the argument is valid. The concept of validity deals with the level of support that premises give their conclusions. In other words, since the premises are the basis on which a conclusion is formed, we should ask how strong the reasons given to support a claim are and whether they necessarily lead to the position put forth. Gaining a clear understanding of the concept of validity is the primary goal of this chapter. Second, quite apart from the question of validity, we should ask whether the premises themselves are acceptable. That is to say, we should first ask whether it is probable that they are true and, second, even if they are thought to be true, whether they are relevant to the argument's conclusion. If the premises of an argument are unacceptable, the argument, even if it is valid, is weak. Instruction in evaluating the strength or acceptability of premises will be our focus in the next three chapters. Finally, we should ask whether the argument contains any of the common or "informal fallacies."

Arguments that both are valid and have acceptable premises (premises believed to be both true and relevant to the argument's conclusion) are called sound arguments.

Ideally, this is the sort of argument we would like to produce in our own thinking and writing.

First, we will examine the question of the relationship between the premises and the conclusion of an argument. The strength of the support that premises give their conclusions varies a great deal. Let's look at the degree of support in terms of probability. If the premises are assumed to be true, then the probability that a conclusion is true ranges from 0% (impossibility) to 100% (certainty). If, given the truth of the premises, the probability that the conclusion is true is 100%, then it is impossible for the premises to be true and the conclusion false. In this case, the truth of the premises guarantees the truth of the conclusion. At the other end of the probability spectrum, there are some arguments in which, given the truth of the premises, the probability of the conclusion being true is 0%. That is to say, the premises are such that even if they are true, it is impossible for the conclusion to be true. This is because those premises entail what is called a logical contradiction: a claim that at the same time both asserts and denies a property or relation of a subject, e.g., "The economy both is and is not healthy" or "The person both is and is not the murderer." In this case, the premises make it impossible for the conclusion to be true.

Contradictory claims, claims that both assert and deny a position, are always false. Arguments with premises that entail contradictions give no support to their conclusions and are the weakest of all arguments. They should be rejected.

Our concern in this chapter is with valid deductive arguments. A deductive argument is an argument whose premises purport to provide conclusive, as opposed to highly probable, grounds for the truth of its conclusion. For the most part the arguments we have looked at so far as formal arguments were deductive arguments because their premises purported to give conclusive support for the truth of their conclusions. A valid deductive argument, then, is a deductive argument whose form is such that whenever the premises are true, the conclusion must also be true. That is to say, if a deductive argument is valid, it is impossible for its premises to be true and the conclusion false. Consider the following example:

P1. If Socrates is a human being, then Socrates is mortal .

P2. Socrates is a human being.

C. Hence, Socrates is mortal.

If accepted, the major premise (P1) and the minor premise (P2), taken together, provide conclusive support for the conclusion. It is intuitively clear that any person who accepts these two premises must also accept the conclusion. If P1 and P2 are true, then the conclusion must also be true. To deny the conclusion after accepting the premises would be to contradict oneself.

Valid deductive arguments are special because in no other kind of argument do the premises provide such strong support for the conclusion. Again, in any valid deductive argument, if the premises are accepted, we must accept the conclusion because the premises entail the conclusion.

The concept of validity applies only to deductive arguments, those arguments whose premises purport to give absolute support for their conclusions. Some arguments may appear to be valid deductive arguments but may be of such a form that their premises, even if they are true, do not guarantee the truth of the conclusion. Those deductive arguments are invalid. While the example above is obviously a valid deductive argument, the following argument is an example of one that is invalid.

P1. If I am in San Francisco, then I am in California.

P2. I am in California.

C. Hence, I am in San Francisco.

This example is invalid because both premises could be true and yet the conclusion false. For example, even though both premises might be true, the person could be in Los Angeles or San Diego or anywhere else in California other than San Francisco. This example shows that not all patterns of reasoning which might seem intuitively plausible are valid.

As we have seen, whenever we pass judgment we imply some set of standards to justify our judgment. So, the first reason to study the notion of valid deductive arguments is that such arguments provide us with a standard or norm by which we can judge the relative strength of other arguments. In any argument except a valid deductive argument, the premises could be true and the conclusion false. In other words, for all arguments other than valid deductive arguments, the probability of their conclusions being true, given the truth of their premises, is less than 100%.

While valid deductive arguments provide a standard by which we judge the strength of other arguments, it is important to remember that we do not need absolute certainty to say that a belief is rational. Many areas of inquiry, such as the social sciences, by virtue of their subject matter do not claim to yield deductive certainty, but rather high probability. Whenever we can estimate the
probability of a claim being true based on its premises, it would seem rational to accept those arguments for which this probability is closer to 100%. It would also seem rational to be skeptical of those arguments for which, based on their premises, this probability is closer to 0% because the odds are against those conclusions being true. Certainty is an ideal, but certainty is not necessary for critical thinking or rational beliefs.

One reason arguments that do not measure up to the absolute standard of valid deductive arguments are not necessarily bad is that many arguments are not intended to be valid deductive arguments and, hence, should not be judged by the high standards of deduction. Such arguments are usually called inductive arguments.

The premises of an inductive argument are not intended to provide absolute support for their conclusion, only strong support such that if the premises are true, it is probable that the conclusion is true.

Again, the premises of an argument can give strong support for a conclusion without yielding absolute certainty. However, given the uncertainty of their conclusions, we must evaluate inductive arguments carefully to see if it is reasonable to accept their conclusions given the evidence provided in their premises.

A second reason to study the concept of valid deductive arguments is that their validity is based on the notion of logical form, that is, the formal relationship of the premises to the conclusion. Logical form is important because by understanding specific forms or patterns of deductive reasoning, we can develop strategies for constructing arguments to support our own views. This is especially valuable when we are asked to write papers.

Formal deductive logic, the concept of validity, and the nature of logical form are complex and well-understood areas of study. Since our primary purpose is to apply evaluative techniques to what we read and write, we can limit our study to just three of the more common valid deductive patterns:

Modus Ponens

Modus Tollens, and

Disjunctive Syllogism.

From these three patterns, most complex arguments can be constructed.

The Nature of Validity

In order to determine whether or not an argument is valid, we must ask whether the premises, if we accept them as

true, make it impossible for the conclusion to be false. The "if", here is very important. To ask whether an argument is valid is not to ask whether the premises are true; it is rather to ask in a conditional manner whether the premises, if they were true, would guarantee
the truth of the conclusion. Hence, whether or not an argument is valid is determined by a special relationship between the premises and the conclusion and has nothing to do with the actual truth or falsity of the premises.

The relationship between the premises and conclusion of a valid deductive argument is so strong that if the premises are assumed to be true, then it is impossible for the conclusion to be false. How does the assumed truth of the premises of a valid deductive argument guarantee the truth of the conclusion? It is because of the argument's logical form that the truth-value of "true" found in the premises is always transferred to the conclusion. Because of their form, valid deductive arguments are "truth preserving" in the highest sense.

Because the validity of a deductive argument is determined by its logical form, let us see if we can understand what is meant by this important concept. For the most part, human knowledge begins with our ability to recognize general patterns in what first appears to be an unorganized group of individual things or events. We understand particular events or things only after we see
them as examples of general formal patterns, structures, or types. Perhaps a few examples will clarify this assertion.

Just as one can study the content or material parts of a subject, one can also study its form. To study the logical form of arguments is no more complex or unique than to study the formal properties of any other subject. For example, in a literature class, one may study the formal structure of a play or novel; in a music class, one may study the formal characteristics of a piece of music; and in a math class, one may study the pattern of an algebraic equation. The logical form of a deductive argument, like that of a play, is the formal pattern followed by the argument. Like the dialogue and content of a play, the specific premises and conclusions of deductive arguments will vary, but the form or pattern will remain the same.

Beyond the classroom, the distinction between the formal and material parts of a practice is common. When we study the art of cooking, we quickly see that good cooks follow a recipe that tells them how to arrange the ingredients of a dish. The recipe prescribes a formal pattern or structure that can be applied universally to groups of particular material ingredients in order to create the desired dish. For example, a recipe for bread prescribes a pattern that tells us how to combine the materials of flour, yeast, oil, and water such that they become loaves of bread, rather than pizza crust. If the dish turns out poorly, it is usually because the ingredients either were structured in an improper way or were of substandard quality; e.g., the amount of yeast was inadequate in proportion to the other ingredients, or the yeast may have been old. In an analogous fashion, we shall see that if an argument is bad, it is either because its form is not that of a valid argument or because the premises (the ingredients of the argument) are unacceptable, that is, questionable or false. As we said in the last section, good or sound arguments have both a proper logical form and acceptable premises.

Arguments, like other human practices or creations, consist of specific premises and conclusions and exemplify certain general formal patterns. While the content of the sentences that make up arguments varies greatly, valid arguments follow certain general patterns that are easily identified. It is precisely because valid deductive arguments follow specific formal patterns that their premises, if true, entail that their conclusions must be true. We refer to these formal patterns as their logical form.

Identifying Logical Form

If it is essential to identify the logical form of an argument prior to determining its validity, how do we go about it? Consider the following examples of formal arguments:

P1. If dogs are mammals, then dogs have hair.

P2. Dogs are mammals.

C. Hence, dogs have hair.

P1. If Sally fails to get enough rest, then she will be sick.

P2. Sally fails to get enough rest.

C. Hence, she will be sick.

P1 If we continue to pollute the atmosphere, then the earth's temperature will rise.

P2. We continue to pollute the atmosphere.

C. Hence, the earth's temperature will rise.

All of these arguments, while completely different in terms of their subject matter, are alike in an important way: each has the same logical form. Each argument, as we learned in Chapter Three, has what we will call a major premise. The major premise is the conditional statement: "If____, then _______ . " We should remember that conditional statements consist of two parts: the antecedent, or the part of the statement which follows the "if," and the consequent, or the part of the statement which follows the "then." Each argument also has a second or minor premise, which repeats what is claimed in the antecedent of the major premise. Finally, each argument also has a conclusion, which repeats what is claimed the consequent of the major premise. While different in subject matter, each of the three arguments above shares these same three characteristics. They share the same pattern or logical form.

How can we identify this form? In chapter one we saw that certain words tend to indicate premises while others indicate conclusions. This helped us to make the distinction between premises and conclusions and thus between opinions and arguments. Likewise, within the sentences that make up any argument, we can make a fundamental distinction between propositions and logical connectives. By making such a distinction, we can more easily see the logical form shared by the three arguments given at the beginning of this section. Propositions are sentences that have a truth-value of either true or false and do not contain logical connectives. Given this definition, propositions cannot be commands or questions, because these two types of sentences are neither true nor false. Propositions say something about something, and what they say is either true or false. For example, the sentences, "Dogs are mammals" and "Dogs have hair," are propositions in the first argument above. Logical connectives are words that join individual propositions to create complex sentences. They include the words and, or, if, then, and, not. The sentences, "If dogs are mammals, then dogs have hair," are two propositions joined by the logical connective if-then to create a complex sentence. As we have already seen, words such as hence and thus are used to indicate conclusions, such as "Hence, dogs have hair."

In all three examples above, the logical connective if then occurs in the first premise. If we let the place markers _____ and _____ represent the two propositions that make up the antecedent and consequent, we can see the logical form of the complex sentence and of the entire argument:

P1. If ____, then P2. _____ C. Hence _______.

By distinguishing between the propositions and the logical connectives in each argument, we can see that each of our three examples exemplifies this same logical form. Each argument shares the same pattern and is an example of a common valid argument form called Modus Ponens, which means "to reason from the positive mode." Modus Ponens is a way of deriving the proposition in the consequent of a conditional statement by showing that the antecedent of the conditional is true. To identify the pattern, we need only to distinguish between an argument's propositions and its logical connectives and replace the propositions with place markers.

Modus Ponens, or arguing by affirming the antecedent of a conditional, is a valid argument form because no matter what propositions or complex sentences we substitute uniformly for the place markers in the argument, if the premises are true, it will be impossible for the Conclusion to be false. There are no instances of arguments that follow the Modus Ponens pattern that have
true premises and a false conclusion. As a form of reasoning, Modus Ponens is truth preserving in the highest sense.

Rather than using place markers to identify an argument's formal structure, it is less cumbersome and more comprehensible to use letters or combinations of letters to represent the particular propositions that make up the

argument. When we symbolize specific arguments to show their logical form, it is useful to choose letters that bear some resemblance to the actual sentences or
propositions for which they stand. This allows us to avoid unnecessary confusion when we symbolize more complicated arguments. For example, the premise, "If dogs are mammals, then dogs have hair," could be symbolized as "If DM, then DH." The letters DM have a greater similarity to the sentence "Dogs are mammals" than does D. If we symbolize arguments in this way, then the logical form of the argument can be symbolized thus:

P1. If dogs are mammals, then dogs have hair. If DM, then DH

P2. Dogs are mammals. DM

C. Hence, dogs have hair. Hence, DH

As a matter of convention, the letters x, y, and z are not used to symbolize specific propositions but rather are reserved for special functions in symbolic logic. It is also the custom to use the letters p, q, and r to symbolize general argument patterns, such as Modus Ponens, rather than particular arguments that may be instances of such patterns.

Thus the general form of a Modus Ponens argument is as follows:

If p, then q

p

Hence, q Modus Ponens pattern (or MP)

Modus Ponens formally represents what is called the entailment principle. The entailment principle is an informal rule to guide critical discussions. It states that a position has been successfully defended if it is logically entailed by other mutually acceptable claims. The Modus Ponens pattern of inference tells us that a position (q) is logically supported if certain conditions (p) entail the position, and also that those conditions (p) are met. This form of reasoning is a good strategy for proving a position. For example, if we wanted to prove that universal health care is a good policy, we could employ a strategy for proof much like Modus Ponens We
could argue that

P1. If a public policy has certain social benefits (a, b, and c), then it should be adopted .

P2. Universal health care has benefits a, b, and c.

C. Hence, it should be adopted.

The Modus Ponens pattern of reasoning is perhaps the easiest to use, especially for beginners.

Let us use the technique of symbolizing arguments to display the logical form of another valid argument form. This one is called Modus Tollens, or arguing by rejecting the consequent of a conditional. Modus Tollens means "to argue in the negative mode."

With Modus Ponens, we show that if we accept a position (p), then it entails specific consequences (q), but those consequences are unacceptable (not q); hence the position can be rejected (not p). Hence, as its name implies, Modus Tollens is very useful in arguing against a position. Consider the following argument:

P1. If tax rates stay the same, then the deficit will increase.

P2. We do not want the deficit to increase.

C. Hence, tax rates cannot stay the same.

Remember that to identify the logical form of any argument, we first distinguish any logical connectives (and, or, if/then, and not) from the propositions. We then choose appropriate letters to represent the individual propositions. When we do this, the argument above can be symbolized as follows:

If TS, then DI

Not DI

Hence, not TS

Notice that we interpret the not in the second premise and in the conclusion to mean that a claim made in the first premise is being denied. The sentence "We do not want the deficit to increase" means that "It is not the case that we want the deficit to increase." Hence, we symbolize it as "not DI."

The general logical form of a Modus Tollens argument is as follows:

If p, then q

Not q

Hence, not p Modus Tollens pattern (or MT)

Like Modus Ponens, Modus Tollens is a valid argument form because we cannot substitute uniformly sets of propositions for the variables such that the premises are true and the conclusion is false. Modus Tollens is truth preserving because it is a pattern of reasoning that does not allow us to infer false conclusions from true premises.

Modus Tollens is a formal principle of reasoning that follows what we can call the rejection principle. Roughly speaking, the rejection principle states that a position can be rejected if it entails consequences that are false or unacceptable. The Modus Tollens pattern tells us that a position (p) entails a consequence (q) and that consequence is unacceptable or false. Hence, there is good reason to reject the position (not p). Again, this form of reasoning is a good strategy for refuting a position. For example, if we wanted to refute the position that universal health care is a good policy, we could use Modus Tollens and argue that:

P1. If universal health care were adopted, then specific consequences (a, b, and c) would result.

P2. Consequences a, b, and c are unacceptable.

C. Hence, universal health care should not be adopted.

The Modus Tollens pattern of reasoning is perhaps the most often used form of reasoning in the sciences. For example, scientists test proposed theories by postulating sets of observable consequences that would follow should the theory be true: if theory A, then consequence B should follow. But if the observable consequences do not follow (not B), then scientists have good reason to reject the theory. If the consequences do follow, while the theory has not been proven absolutely true, scientists believe they have confirming evidence that the theory is acceptable.

Let us consider one more valid argument form that is often used. This one is called a Disjunctive Syllogism. Consider the following examples:

P1. We must do our best to hire women and minorities or continue to live in a society with vast inequalities in power and wealth.

P2. We do not want to continue to live in a society with vast inequalities in power and wealth .

C. Hence, we must do our best to hire women and minorities.

Again to display the argument's logical form we first distinguish the logical connectives (and, or, if/then, and not) from the propositions and then choose appropriate letters to represent the propositions. When we do this, the argument above can be symbolized as follows:

P1. HWM or CI

P2. Not CI

C. Hence, HWM

This valid form of deductive reasoning, in which two or more alternatives are proposed and then all but one eliminated, is often used in scientific as well as criminal investigations. For example, police detectives often put together a list of suspects for a crime and then narrow the list by crossing off all who can account for their whereabouts at the time of the crime. If the list of suspects includes all who could possibly have committed the crime, then the one who cannot provide an account of where he or she was at the time of the crime is, by the process of Disjunctive Syllogism, the criminal . The general form of a Disjunctive Syllogism is as follows:

P1. p or q

P2. Not p

C. Hence, q Disjunctive Syllogism pattern (or DS)

One strategy for eliminating one part of a disjunction (p or q) is to apply Modus Tollens to the part to be negated. For example, if we want to eliminate one alternative (p), we show that that alternative entails a consequence (r) and that that consequence is unacceptable. Hence the alternative is unacceptable (not p). Consider the following reasoning process that follows just this pattern:

P1. I'll go into either medicine or biology.

P2. If I go into medicine, then I must pass organic chemistry.

P3. I could never pass organic chemistry.

P4. I will not go into medicine. (P2, P3, p4-Modus Tollens [MT])

C. Hence, I will go into biology. (P1, P4, C-Disjunctive Syllogism [DS])

Arguments that follow the valid patterns of Modus Ponens, Modus Tollens, Disjunctive Syllogism, or combinations of these are common and useful. Many more complex patterns of valid reasoning turn out to be combinations of these simple patterns. Later we will consider more formal instruction in proving that these, as well as other argument forms, are valid. For now it is enough to see that these common forms are valid because they are such that if one accepts their premises, then one cannot reject the conclusion. Try as we may, there is no set of propositions that can be uniformly substituted in any of these three argument forms such that the premises are true and the conclusion false.

Exercises:

A. Symbolize the following arguments so their logical form is displayed. Then tell whether each is an invalid form or an example of Modus Ponens, Modus Tollens, Disjunctive Syllogism, or a combination. Explain how you made each decision.

Example:

Argument: If Sally does not work after school, she cannot make her car payments. She must make her car payments. Hence, Sally will work after school.

Symbolization:

P1. If not WAS, then not CP

P2. CP

C. WAS Modus Thollens (MT)

Explanation:

It is Modus Tollens because the first premise is a conditional and the second premise denies what is claimed in the consequent of the conditional. Hence, the antecedent is denied in the conclusion.

1. If bacteria is in the egg salad, then the guests will become ill. The guests do not become ill. Hence, bacteria is not in the egg salad.

2. Sally is either a sophomore or a junior. Sally is not a junior. Hence, Sally is a sophomore.

3.If Joe winks at Sally, then Joe is interested in dating her. Joe winks at Sally. Hence, Joe is interested in dating her.

4. The universe is the result of chance, or it is the result of design. The evidence suggests the universe is not the result of chance. Hence, it is likely that it is the result of design.

5. If there are virtuous leaders, then there will be virtuous citizens. There are not virtuous leaders. Hence, there are not virtuous citizens.

6. Sally is bored or she is sick. She is not sick. Hence, she is bored.

7. If Sally studies for the test, then she will pass. She does not study for the test. Hence, she will not pass.

8. If we spend enough money, then poverty will end . Poverty has not ended . Hence, we have not spent enough money.

9. I will either go on a diet or have my pants altered. If I go on a diet, then I'll be too hungry to study well. I must study well. Hence, I will not go on a diet, but rather have my pants altered .
10. I'll either go to the Rocky Mountains or stay home and read. If I want to save money, then I will stay home and read. I don't want to save money. So I won't stay home and read. Hence, I'll go to the Rocky Mountains.

B. For each of the following conclusions, construct a valid Modus Ponens, Modus Tollens, or Disjunctive Syllogism argument. Do not use any form over three times.

Example:

Conclusion: Taxes must be raised.

Modus Ponens argument:

P1. If we want to lower the federal deficit, then taxes must be raised.

P2. We want to lower the federal deficit.

C. Hence, taxes must be raised.

Modus Tollens argument:

P1. If we do not raise taxes, then the federal deficit will increase.

P2. We do not want the federal deficit to increase.

C. Hence, taxes must be raised.

Disjunctive Syllogism argument:

P1. Either we must raise taxes or the federal deficit will increase.

P2. We do not want an increased federal deficit.

C. Hence, taxes must be raised.

1. Adequate medical care should (or should not) be guaranteed to all people.

2. Handguns should (or should not) be banned.

3. Prostitution should (or should not) be legal.

4. The private lives of public officials should (or should not) be a matter of public record.

5. The traditional family can (or can not) survive in the modern technological world

6. Individual happiness does (or does not) necessarily lead to the communal good

7. Participation in college athletics should (or should not) be given academic credit.

8. Nuclear power should (or should not) be eliminated.

9. Feminism has (or has not) had a positive effect on society.

10. Burning the flag should (or should not) be a crime.

Implications:

When we have identified an argument as either valid or invalid, what have we shown?

First, to show that an argument is invalid is to show that the premises given in support of a conclusion can be accepted as true without our being forced to accept the conclusion.

Second, if we show that an argument is formally valid, we know that if the premises are accepted as true, then we must accept the conclusion because in valid arguments the truth value of the premises is always transferred to the conclusion. To understand this is to appreciate the force of reasoned argument. Independent of the subject matter, if the argument form is valid and we accept the premises, we are forced to accept the conclusion; whether we like the conclusion is not the issue.

Third, given our understanding of validity, we know that if an argument is valid but the conclusion makes a claim that we know to be false or highly questionable, then we can be sure that at least one of the premises is false or highly questionable. If all premises were, in fact, true and the argument valid, then it would be impossible for the conclusion to be false. We would have an example of a sound argument.

Fourth, our notion of validity tells us that if one accepts a conclusion, then one must also accept whatever premises are necessary in order to imply the truth of the conclusion. For example, if I accept a conclusion (q) and the only way to support it is to accept the premises [(If p then q) and (p)1, then I must accept the truth of those premises. We should be aware that people who present
arguments usually do not present their positions in the form of formal deductive arguments. However, it is usually possible to reconstruct their arguments so that the missing premises needed for a formal argument are made evident. When this is done, it is easier to assess the strength of the argument.