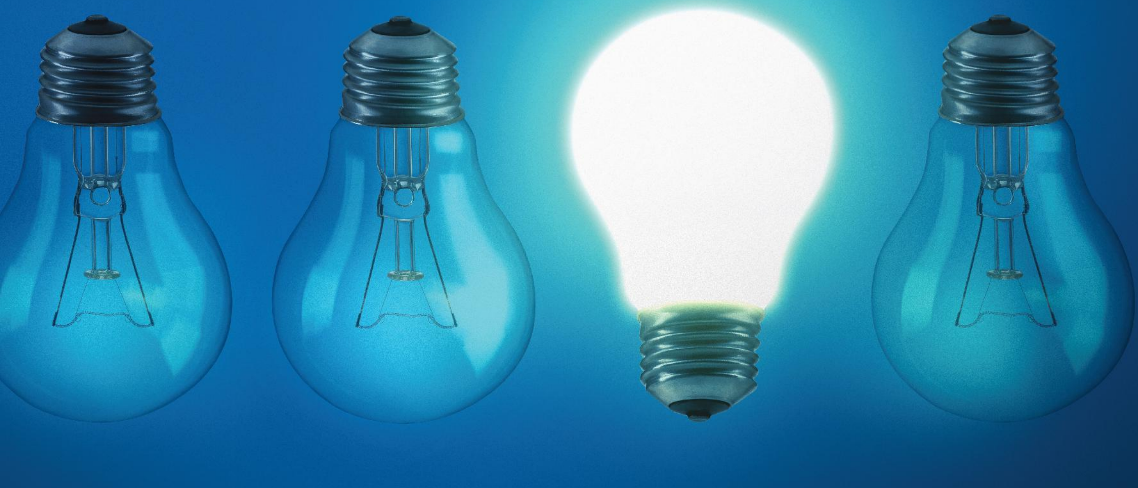
Sixth Edition

THE POWER OF LOGIC



Frances Howard-Snyder
Daniel Howard-Snyder
Ryan Wasserman

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The Power of Logic

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SIXTH EDITION

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WESTERN WASHINGTON UNIVERSITY

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To our children

Peter

William

Benjamin

and Zoë Mae

About the Authors

Frances Howard-Snyder is Professor of Philosophy at Western Washington University, where she has taught since 1993. She has a PhD in philosophy from Syracuse University and an MA from the University of Cape Town. She has published articles on topics in normative ethics, philosophy of religion, and metaphysics in *The Journal of Philosophy, American Philosophical Quarterly,* and *Philosophical Studies,* among other places. When she is not doing philosophy, she enjoys writing (and reading) fiction and also spending time with her husband, Dan, and her twins, Peter and William.

Daniel Howard-Snyder is Professor of Philosophy at Western Washington University, where he has taught since 2000. He has a PhD from Syracuse University and a BA from Seattle Pacific University. He is editor or co-editor of four books, *The Evidential Argument from Evil* (Indiana University Press, 1996), *Faith, Freedom, and Rationality* (Rowman & Littlefield, 1996), *Divine Hiddenness* (Cambridge, 2002), and *The Blackwell Companion to the Problem of Evil* (Blackwell, 2013). He has published articles in, among other places, *Philosophy and Phenomenological Research, American Philosophical Quarterly, and Faith and Philosophy.* His chief love is his family—Frances, William, and Peter—without whom his life would be bereft of all joy.

Ryan Wasserman is Professor and Chair of Philosophy at Western Washington University, where he has taught since 2005. He has a PhD from Rutgers University and a BA from Western Washington University. His main philosophical interests are in metaphysics, ethics, and the philosophy of language. He has published articles in many journals, including *Mind, Noûs,* and *Philosophical Quarterly.* He is also the author of *Paradoxes of Time Travel* (Oxford University Press, 2018) and a co-editor of *Metametaphysics* (Oxford University Press, 2008). Apart from philosophy, Ryan enjoys playing basketball, watching football, and spending time with his family.

Brief Contents

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Preface

Critical thinking skills are some of the most prized commodities in today's knowledge-based economy, and the study of logic is one of the best ways to develop these skills. With its emphasis on presenting, understanding, and evaluating arguments, logic has the power to make us quicker, clearer, and more creative thinkers. It can help us to articulate and support our own views and to analyze the views of others.

In short, there are many benefits to the study of logic. But there are also potential obstacles. Logic can be intimidating. It can be frustrating. It can even be *boring.*

The Power of Logic is written with the hopes of removing these kinds of obstacles. The book features a simple and direct writing style that helps makes even the most technical matters approachable. It features a wealth of helpful tips and on-line resources to combat common frustrations. And it includes hundreds of examples and exercises that give readers the opportunity to apply their critical thinking skills to interesting arguments from philosophy, politics, and religion. Our hope is that these features help to make logic accessible and interesting and that they enable you to put the power of logic to work in your own life.

New Features

We have made many improvements in light of critical reviews and our classroom experience with previous editions. We have also made some very specific improvements as follows:

- The book has been heavily rewritten, with a focus on improving specific sections that students have struggled with in the past.
- As a new feature, we have introduced many "Bright Idea" boxes throughout the text, highlighting important tips and reminders.
- There are many new definition boxes, which emphasize key concepts and important distinctions.
- There are several new summary boxes, with simple, clear descriptions for quick reference and study.
- Chapter 5 has been completely rewritten, with new introductions to moods, forms, and immediate inferences.

- Chapter 6 has also been completely rewritten, with new sections, more exercises, and a more detailed discussion of the problems with the Traditional Square of Opposition.
- Chapters 7 and 8 include over 250 new exercises, helping the student through some of the most challenging sections of the book.
- Chapter 10 includes a more detailed (and more accurate) section on sampling errors, including a new discussion of margins of error and levels of confidence.
- Chapter 10's treatment of scientific reasoning has been completely rewritten in order to (we believe) more accurately represent Mill's methods.
- Chapter 10 also includes a new discussion of the fine-tuning argument as an illustration of how Bayes' theorem might be applied to a traditional philosophical debate.

Enduring Features

We have retained many of the features that have made *The Power of Logic* successful in the past.

- Early chapters focus on relatively informal methods. More technical material is introduced gradually, with symbolic logic receiving thorough treatment in Chapters 7–9.
- The writing is concise and lively throughout the text. The chapter on truth tables includes a discussion of the material conditional and its relation to the English "if-then" and emphasizes abbreviated truth tables.
- The system of natural deduction for statement logic is entirely standard, consisting of 8 implicational rules, 10 equivalence rules, conditional proof, and *reductio ad absurdum.*
- The chapter on inductive logic includes standard material on statistical syllogisms, induction by enumeration, arguments from authority, Mill's methods, scientific reasoning, and arguments from analogy. It also includes an accessible introduction to the probability calculus.
- The exercises on arguments from analogy require students to evaluate a stated criticism of each argument, which makes the exercises relatively easy to grade.

As in previous editions, various paths through this book are possible, depending on the time available, the needs of the students, and the interests of the instructor. Here are three possibilities:

- A course emphasizing traditional and informal logic, covering Chapters 1–6 and 10: Basic Concepts, Identifying Arguments, Logic and Language, Informal Fallacies, Categorical Logic: Statements, Categorical Logic: Syllogisms, and Inductive Logic

- A course giving roughly equal emphasis to informal and symbolic logic, covering Chapters 1–4, 7, and 8: Basic Concepts, Identifying Arguments, Logic and Language, Informal Fallacies, Statement Logic: Truth Tables, and Statement Logic: Proofs
- A course emphasizing symbolic methods, covering Chapters 1 and 2, 7–9, and section 10.4: Basic Concepts, Identifying Arguments, Statement Logic: Truth Tables, Statement Logic: Proofs, Predicate Logic, and Probability

Supplements

The sixth edition of *The Power of Logic* is accompanied by an updated version of the popular website, www.poweroflogic.com. This site provides accessibility to an on-line *Logic Tutor,* allowing students to do the vast majority of the book's exercises on-line with feedback. This includes creating Venn diagrams, truth tables, and proofs.

Acknowledgments

Many people have helped improve this text throughout the years. Our greatest debt is to C. Stephen Layman, who authored the first three editions of *The Power of Logic* and is responsible for many of its best features. We also thank Allison Rona, Anne L. Bezuidenhout, Benjamin Schaeffer, Bernard F. Keating, Charles R. Carr, Charles Seymour, Cynthia B. Bryson, Darian C. De Bolt, Eric Kraemer, Eric Saidel, George A. Spangler, Greg Oakes, Gulten Ilhan, James K. Derden, Jr., Jason Turner, Jeffrey Roland, Jen Mills, John Casey, Jon-David Hague, Jordan J. Lindberg, Joseph Le Fevre, Keith W. Krasemann, Ken Akiba, Ken King, Maria Cimitile, Mark Storey, Martin Frické, Michael F. Wagner, Michael Rooney, Mitchell Gabhart, Nancy Slonneger Hancock, Neal Hogan, Ned Markosian, Nils Rauhut, Otávio Bueno, Patricia A. Ross, Paul Draper, Paul M. Jurczak, Peter Dlugos, Phil Schneider, Phillip Goggans, Rachel Hollenberg, Richard McClelland, Rico Vitz, Robert Boyd Skipper, Ron Jackson, Sander Lee, Sandra Johanson, Ted Sider, Terence Cuneo, Tom Downing, Ty Barnes, William J. Doulan, Xinmin Zhu, and Naomi Radbourne.

For the sixth edition, we are specifically grateful for comments and suggestions we received from Todd Buras, Benjamin M. Guido, Douglas E. Hill, Peter Howard-Snyder, William Howard-Snyder, Frederick Longshore-Neate, Chris Menzel, Alexander Pruss, John Robertson, August Waldron, and our project team at McGraw-Hill Higher Education.

Finally, as always, we thank our families—especially our children—for their patience and understanding during the revision process. It is to them that we dedicate this book.

Frances Howard-Snyder
Daniel Howard-Snyder
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The Power of Logic

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CHAPTER 1

Basic Concepts

Everyone thinks. Everyone reasons. Everyone argues. And everyone is subjected to the reasoning and arguing of others. We are bombarded daily with reasoning from many sources: books, speeches, radio, TV, newspapers, employers, friends, and family.

Some people think well, reason well, and argue well. Some do not. The ability to think, reason, and argue well is partly a matter of natural gifts. But whatever our natural gifts, they can be refined and sharpened. And the study of logic is one of the best ways to refine one's natural ability to reason and argue. Through the study of logic, one learns strategies for thinking well, common errors in reasoning to avoid, and effective techniques for evaluating arguments.

But what is logic? Roughly speaking, logic is the study of methods for evaluating arguments. More precisely, **logic** is the study of methods for evaluating whether the premises of an argument adequately support (or provide good evidence for) its conclusion.

> **Logic** is the study of methods for evaluating whether the premises of an argument adequately support its conclusion.

To get a better grasp of what logic is, then, we need to understand the key concepts involved in this definition: argument, conclusion, premise, and support. This chapter will give you an initial understanding of these basic concepts.

An **argument** is a set of statements where some of the statements are intended to support another. The **conclusion** is the claim to be supported. The **premises** are the statements offered in support. In some arguments, the conclusion is *adequately supported* by the premises; in other cases it is not. But a set of statements counts as an argument as long as some of the statements are intended to support another. Here is an example:

1. Every logic book contains at least one silly example. *The Power of Logic* is a logic book. So, *The Power of Logic* contains at least one silly example.

The word "so" indicates that the conclusion of this argument is "*The Power of Logic* contains at least one silly example." The argument has two premises—"Every logic book contains at least one silly example" and "*The Power of Logic* is a logic book." Of course, many arguments deal with very serious matters. Here are two examples:

2. If something would have a future of value if it weren't killed, then it is wrong to kill it. Most fetuses would have a future of value if they weren't killed. So, it is wrong to kill most fetuses.
3. If fetuses are not persons, then abortion is not wrong. Fetuses are not persons. So, abortion is not wrong.

As with argument (1), the sentences that precede the word "so" in arguments (2) and (3) are the premises and the sentence that follows the word "so" is the conclusion.

An **argument** is a set of statements where some of the statements, called the **premises**, are intended to support another, called the **conclusion**.

What is a statement? A **statement** is a declarative sentence that is either true or false. For example:

4. Some dogs are collies.
5. No dogs are collies.
6. Some dogs weigh exactly 124.379 pounds.

(4) is true because it describes things as they are. (5) is false because it describes things as other than they are. Truth and falsehood are the two possible **truth values.** So, we can say that a statement is a declarative sentence that has a truth value. The truth value of (4) is true while the truth value of (5) is false, but (4) and (5) are both statements. Is (6) a statement? Yes. No one may know its truth value, but (6) is either true or false, and hence it is a statement.

A **statement** is a declarative sentence that is either true or false.

Are any of the following items statements?

7. Get your dog off my lawn!
8. How many dogs do you own?
9. Let's get a dog.

No. (7) is a *command,* which could be obeyed or disobeyed. But it makes no sense to say that a command is true or false, so it is not a statement. (8) is a *question,* which could be answered or unanswered. But a question cannot be true or false, so it is not a statement. Finally, (9) is a *proposal,* which could be accepted or rejected. But a proposal cannot be true or false, so it also fails to be a statement.

A statement is **true** because it describes things as they are.
A statement is **false** because it describes things as they are not.

We have said that an argument is a set of statements, where some of the statements (the premises) are intended to support another (the conclusion).[1] We must now distinguish two ways the premises can be intended to support the conclusion, and hence two different kinds of arguments. A **deductive argument** is one in which the premises are intended to *guarantee* the conclusion. An **inductive argument** is one in which the premises are intended to make the conclusion *probable,* without guaranteeing it. The following two examples illustrate this distinction:

10. All philosophers like logic. Neal is a philosopher. So, Neal likes logic.
11. Most philosophers like logic. Neal is a philosopher. So, Neal likes logic.

The premises of argument (10) are intended to support the conclusion in this sense: It is *guaranteed* that, if they are true, then the conclusion is true as well. (10) is an example of a deductive argument. The premises of argument (11) do *not* support the conclusion in this same sense. Even if Neal is a philosopher and even if the majority of philosophers enjoy logic, it is not guaranteed that Neal enjoys logic; he might be among the minority who do not care for logic at all. The premises of (11) are intended to support the conclusion in a different sense, however: It is *probable* that if they are true, then the conclusion is true as well. (11) is an example of an inductive argument.

A **deductive argument** is one in which the premises are intended to *guarantee* the conclusion. An **inductive argument** is one in which the premises are intended to make the conclusion *probable,* without guaranteeing it.

Earlier, we said that logic is the study of methods to evaluate arguments. Since there are two kinds of arguments, there are also two areas of logic. **Deductive logic** is the study of methods for evaluating whether the premises of an argument guarantee its conclusion. **Inductive logic** is the study of methods for evaluating whether the premises of an argument make its conclusion probable, without guaranteeing it.[2] The first three sections of this chapter introduce some of the key elements of deductive logic. The fourth section focuses on inductive logic.

1.1 Validity and Soundness

A deductive argument is one in which the premises are intended to guarantee the conclusion. Of course, one can *intend* to do something without *actually* doing it—just as the best-laid plans of mice and men often go awry, so deductive arguments often go wrong. A **valid argument** is a deductive argument in which the premises *succeed* in guaranteeing the conclusion. An *invalid* argument is a deductive argument in which the premises *fail* to guarantee the conclusion. More formally, a valid argument is one in which it is necessary that, if the premises are true, then the conclusion is true.

A **valid argument** is one in which it is necessary that, if the premises are true, then the conclusion is true.

You should memorize all the definitions, but some are more important than others. Memorize *valid argument*.

Two key aspects of this definition should be noted immediately. First, note the important word "necessary." In a valid argument, there is a *necessary connection* between the premises and the conclusion. The conclusion doesn't just happen to be true given the premises; rather, the truth of the conclusion is absolutely guaranteed given the truth of the premises. That is, a valid argument is one in which it is absolutely *impossible* for the premises to be true while the conclusion is false. Second, note the conditional (if-then) aspect of the definition. It does not say that the premises and conclusion of a valid argument are in fact true. Rather, the definition says that, necessarily, *if* the premises are true, then the conclusion is true. In other words, if an argument is valid, then it is necessary that, *on the assumption that* its premises are true, its conclusion is true also. Each of the following arguments is valid:

12. All biologists are scientists. John is not a scientist. So, John is not a biologist.

13. If Alice stole the diamonds, then she is a thief. And Alice did steal the diamonds. Hence, Alice is a thief.
14. Either Bill has a poor memory or he is lying. Bill does not have a poor memory. Therefore, Bill is lying.

In each case, it is necessary that if the premises are true, then the conclusion is true. Thus, in each case, the argument is valid.

In everyday English, the word "valid" is often used simply to indicate one's overall approval of an argument. But not in logic. In logic, the word "valid" is used only to indicate that an argument is such that, necessarily, if the premises are all true, then the conclusion is true.

The following observations about validity may help prevent some common misunderstandings. First, notice that an argument can have one or more false premises and still be valid. For instance:

15. All birds are animals. Some cats are birds. So, some cats are animals.

Here, the second premise is plainly false, and yet the argument is valid, for it is necessary that *if* the premises are true, the conclusion is true also. And in the following argument, both premises are false, but the argument is still valid:

16. All sharks are birds. All birds are predators. So, all sharks are predators.

Although the premises of this argument are in fact false, it is impossible for the conclusion to be false while the premises are true. So, it is valid.

Second, we cannot rightly conclude that an argument is valid simply on the grounds that its premises are all true. For example:

17. Some Americans are women. Ashton Kutcher is an American. Therefore, Ashton Kutcher is a woman.

The premises here are true, but the conclusion is false. So, obviously, it is possible that the conclusion is false while the premises are true; hence, (17) is not valid. Is the following argument valid?

18. Some Americans work in the television industry. Ellen DeGeneres is an American. Hence, Ellen DeGeneres works in the television industry.

Here, we have true premises and a true conclusion. But it is not necessary that, if the premises are true, then the conclusion is true. (Ms. DeGeneres could switch to another line of work while remaining an American and while some Americans continue to work in the television industry.) So, even if an argument has true premises and a true conclusion, it might not be valid. Thus, the question "Are the premises and the conclusion actually true?" is distinct from the question "Is the argument valid?"

Third, suppose an argument is valid and has a false conclusion. Must it then have at least one false premise? Yes. If it had all true premises, then it would have to have a true conclusion because it is valid. *Validity preserves truth;* that is, if we start with truth and reason in a valid fashion, we will always wind up with truth.

Fourth, does validity also preserve falsehood? In other words, if we start with false premises and reason validly, are we bound to wind up with a false conclusion? No. Consider the following argument:

19. All Martians are Republicans. All Republicans are extraterrestrials. So, all Martians are extraterrestrials.

Is this argument valid? Yes. It is impossible for the conclusion to be false *assuming that* its premises are true. However, the premises here are false while the conclusion is true. So, *validity does not preserve falsehood*. In fact, false premises plus valid reasoning may lead to either truth or falsity, depending on the case. Here is a valid argument with false premises and a false conclusion:

20. All highly intelligent beings are from outer space. Some armadillos are highly intelligent beings. So, some armadillos are from outer space.

The lesson here is that although valid reasoning guarantees that we will end up with truth if we start with it, valid reasoning does not guarantee that we will end up with falsehood if we start with it.

Fifth, notice that we can know whether an argument is valid or invalid even if we do not know the truth value of the conclusion and all of the premises. Consider this example:

21. All Schnitzers are BMWs. Emily Larson owns a Schnitzer. So, Emily Larson owns a BMW.

Chances are that you have no idea whether the conclusion and all of the premises are true, but this argument is obviously valid; it is not possible for Emily not to own a BMW on the assumption that she owns a Schnitzer and all Schnitzers are BMWs. Here is another example:

22. All reliabilists are foundationalists. William Alston is a foundationalist. Thus, William Alston is a reliabilist.

You probably haven't the foggiest idea what the truth values of these statements are; indeed, you might not even know what they mean. Nevertheless, you can tell that this argument is invalid because the premises do not rule out the possibility that Alston is a foundationalist of a nonreliabilist stripe.

Earlier, we said that an invalid argument is a deductive argument in which the premises fail to guarantee the conclusion. More formally, an **invalid argument** is one in which it is *not* necessary that, if the premises are true, then the conclusion is true.

An **invalid argument** is one in which it is *not* necessary that, if the premises are true, then the conclusion is true.

In other words, an invalid argument is one in which it is *possible* for the premises to be true while the conclusion is false. Even on the assumption that the premises are true, the conclusion could still be false. Each of the following arguments is invalid:

23. All dogs are animals. All cats are animals. Hence, all dogs are cats.
24. If Pat is a wife, then Pat is a woman. But Pat is not a wife. So, Pat is not a woman.
25. Phil likes Margo. Therefore, Margo likes Phil.

Since the premises of argument (23) are in fact true but its conclusion is false, it is obviously possible for its premises to be true while its conclusion is false; so, it is invalid. Argument (24) is invalid because its premises leave open the possibility that Pat is an unmarried woman. And (25) is invalid because even if Phil does like Margo, it remains open whether she feels the same way toward him. In each of these cases, then, the conclusion could be false while the premises are true.

The foregoing five points about validity, invalidity, and truth are summarized in the following table:

	Valid argument	**Invalid argument**
True premises True conclusion	1 If Harry loved Dumbledore, then Harry was sad when Dumbledore died. Harry loved Dumbledore. So, Harry was sad when Dumbledore died.	6 Some Americans work in business. Donald Trump is an American. So, Donald Trump works in business.
False premises False conclusion	2 All sharks are birds. All birds are politicians. So, all sharks are politicians.	7 Every genius is a philosopher. Forrest Gump is a philosopher. So, Forrest Gump is a genius.

(*continued*)

	Valid argument	Invalid argument
False premises True conclusion	3 All dogs are ants. All ants are mammals. So, all dogs are mammals.	8 Everything colored is red. Stephen Colbert is a mortician. So, Stephen Colbert is hilarious.
True premises False conclusion	4	9 All dogs are animals. All cats are animals. Hence, all dogs are cats.
Unknown truth value	5 All of the Cappadocians accepted perichoresis. Basil was a Cappadocian. So, Basil accepted perichoresis.	10 Some hylidae are heterophoric. Maggie is heterophoric. So, Maggie is a hylidae.

Notice that validity is not enough all by itself for a *good* deductive argument. A valid argument with false premises can lead to a false conclusion (box 2). Moreover, truth is not enough all by itself for a *good* deductive argument. An invalid argument with all true premises can lead to a false conclusion (box 9). We want our deductive arguments to be valid and to have all true premises. An argument that has both is a *sound argument*. In other words, a valid argument in which all of the premises are true is a **sound argument.**

A **sound argument** is a valid argument in which all of the premises are true.

Memorize *sound argument*.

Because a sound argument is valid and has only true premises, its conclusion will also be true. Validity preserves truth. That's why there is nothing in box 4. The argument in box 1 is sound; here are two more sound arguments:

26. All collies are dogs. All dogs are animals. So, all collies are animals.
27. If Mozart was a composer, then he understood music. Mozart was a composer. Hence, Mozart understood music.

In each case, it is necessary that, if the premises are true, then the conclusion is true; moreover, in each case, all of the premises are true. Thus, each argument is sound.

Valid + All Premises True = Sound

By way of contrast, an *unsound argument* falls into one of the following three categories:

Category 1: It is valid, but it has at least one false premise.

Category 2: It is invalid, but all of its premises are true.

Category 3: It is invalid and it has at least one false premise.

In other words, an **unsound argument** is one that either is invalid or has at least one false premise.

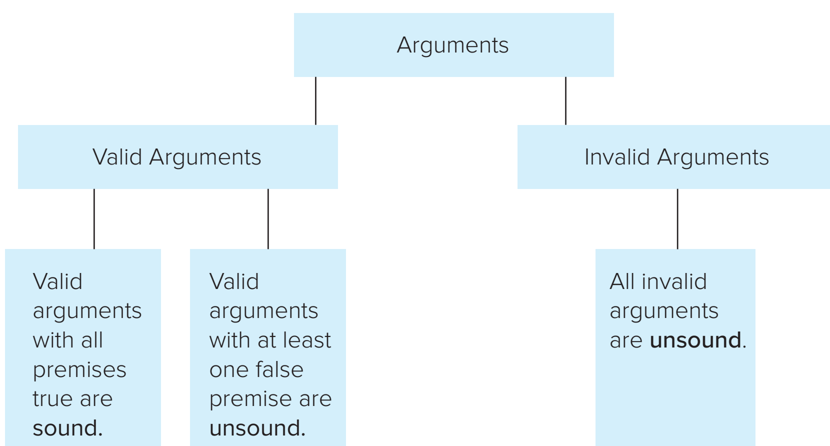
An **unsound argument** is one that either is invalid or has at least one false premise.

For example, these three arguments are unsound:

28. All birds are animals. Some grizzly bears are not animals. Therefore, some grizzly bears are not birds.
29. All birds are animals. All grizzly bears are animals. So, all grizzly bears are birds.
30. All trees are animals. All bears are animals. So, all bears are trees.

Argument (28) is unsound because, although it is valid, it has a false (second) premise. It is in Category 1. Argument (29) is unsound because, although it has all true premises, it is invalid. It is in Category 2. Argument (30) is unsound because it has a false (first) premise and it is invalid. It is in Category 3. (Which boxes in the previous table contain unsound arguments? To which of the three categories does each unsound argument in the table belong?)

Here is a map of the main concepts we've discussed so far:



We said earlier that we want a deductive argument to be valid and have all true premises. That is, we want a deductive argument to be sound. That is *not* to say, however, that if an argument is sound, it leaves nothing to be desired. A sound argument that had its conclusion as a premise would be useless (see section 4.3 on begging the question). Moreover, a sound argument whose premises were not reasonable for us to accept given our total evidence would hardly be a satisfying, compelling, and useful basis for believing the conclusion. To say the least, then, we want more from a deductive argument than its being sound.

Nevertheless, we want a deductive argument to be sound, and deductive logic plays an indispensable role in assessing whether an argument is sound. For an argument is sound only if it is valid, and as we said earlier, deductive logic is the study of methods for evaluating whether the premises of an argument guarantee its conclusion; that is, deductive logic is the study of methods of evaluating whether or not an argument is valid. In the next two sections we will display some initial methods for determining whether or not an argument is valid, and in the process we will get a better handle on the basic concepts that we have introduced thus far. But first, a note on terminology is in order. Given our definitions, arguments are neither true nor false, but each statement is either true or false. On the other hand, arguments can be valid, invalid, sound, or unsound, but statements cannot be valid, invalid, sound, or unsound. Therefore, a given premise (or conclusion) is either true or false, but it cannot be valid, invalid, sound, or unsound.

Summary of Definitions

Logic is the study of methods for evaluating whether the premises of an argument adequately support its conclusion.

An **argument** is a set of statements where some of the statements, called the *premises,* are intended to support another, called the *conclusion.*

A **statement** is a sentence that is either true or false.

A statement is **true** because it describes things as they are. A statement is **false** because it describes things as they are not.

A **deductive argument** is one in which the premises are intended to *guarantee* the conclusion.

An **inductive argument** is one in which the premises are intended to make the conclusion *probable,* without guaranteeing it.

A **valid argument** is one in which it is necessary that, if the premises are true, then the conclusion is true.

An **invalid argument** is one in which it is *not* necessary that, if the premises are true, then the conclusion is true.

A **sound argument** is a valid argument in which all of the premises are true.

An **unsound argument** is one that either is invalid or has at least one false premise.

EXERCISE 1.1

Note: For each exercise item preceded by an asterisk, the answer appears in the Answer Key at the end of the book.

PART A: Recognizing Statements Write "statement" if the item is a statement. Write "sentence only" if the item is a sentence but not a statement. Write "neither" if the item is neither a sentence nor a statement.

* **1.** The sky is blue.
2. Let's paint the table red.
3. Please close the window!
* **4.** Murder is illegal.
5. Abraham Lincoln was born in 1983.
6. If San Francisco is in California, then San Francisco is in the U.S.A.
* **7.** It is not the case that Ben Franklin.
8. "Why?" asked Socrates.
9. Table not yes if.
* **10.** Either humans evolved from apes or apes evolved from humans.
11. Davy Crockett died at the Alamo.
12. How are you?
* **13.** If seven is greater than six, then six is greater than seven.
14. Let's have lunch.
15. Go!
* **16.** Shall we dance?
17. Patrick Henry said, "Give me liberty or give me death."
18. If punishment deters crime.
* **19.** "Stand at attention!" ordered General Bradley.
20. Despite the weather.
21. The longest shark in the Pacific Ocean.
22. Either Heather or Cheri.
23. If there is only one human.
24. Either shut the door or turn off the radio.
25. Do you swear to tell the truth?

26. Having seen all the suffering.
27. Let's stop griping and get to work.
28. Fame is a drug.
29. By faith and love.
30. Either Laura is angry or Edith is depressed.

PART B: True or False? Which of the following statements are true? Which are false?

* 1. All valid arguments have at least one false premise.
2. An argument is a set of statements where some of the statements, called the *premises,* are intended to support another, called the *conclusion.*
3. Every valid argument has true premises and only true premises.
* 4. Logic is the study of methods for evaluating whether the premises of an argument adequately support its conclusion.
5. Some statements are invalid.
6. Every valid argument has true premises and a true conclusion.
* 7. A sound argument can have a false conclusion.
8. Deductive logic is the part of logic that is concerned with tests for validity and invalidity.
9. If a valid argument has only true premises, then it must have a true conclusion.
* 10. Some arguments are true.
11. If a valid argument has only false premises, then it must have a false conclusion.
12. Some invalid arguments have false conclusions but (all) true premises.
* 13. Every sound argument is valid.
14. Every valid argument with a true conclusion is sound.
15. Every valid argument with a false conclusion has at least one false premise.
* 16. Every unsound argument is invalid.
17. Some premises are valid.
18. If all of the premises of an argument are true, then it is sound.
* 19. If an argument has (all) true premises and a false conclusion, then it is invalid.

20. If an argument has one false premise, then it is unsound.

21. Every unsound argument has at least one false premise.

* **22.** Some statements are sound.

23. Every valid argument has a true conclusion.

24. Every invalid argument is unsound.

* **25.** Some arguments are false.

26. If an argument is invalid, then it must have true premises and a false conclusion.

27. Every valid argument has this feature: Necessarily, if its premises are true, then its conclusion is true.

* **28.** Every invalid argument has this feature: It is possibly false that if its premises are true, then its conclusion is true.

29. Every sound argument has a true conclusion.

30. Every valid argument has this feature: Necessarily, if its premises are false, then its conclusion is false.

31. A deductive argument is one in which the premises are intended to make the conclusion probable, without guaranteeing it.

32. An inductive argument is one in which the premises are intended to guarantee the conclusion.

33. Inductive logic is the study of methods for evaluating whether the premises of an argument make its conclusion probable, without guaranteeing it.

34. "It's raining outside, so the ground is wet" is best regarded as a deductive argument.

35. "It must be raining outside. After all, if it weren't, then the ground would be dry, but it's soaking wet" is best regarded as an inductive argument.

PART C: Valid or Invalid? Much of this text concerns methods of testing arguments for validity. Although we have not yet discussed any particular methods of testing arguments for validity, we do have definitions of "valid argument" and "invalid argument." Based on your current understanding, which of the following arguments are valid? Which are invalid? (*Hint:* Use the definitions that have been provided.)

* **1.** If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln was killed in an automobile accident. Hence, Lincoln is dead.

2. If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln was not killed in an automobile accident. Therefore, Lincoln is not dead.

3. If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln is dead. So, Lincoln was killed in an automobile accident.

* 4. If Lincoln was killed in an automobile accident, then Lincoln is dead. Lincoln is not dead. Hence, Lincoln was not killed in an automobile accident.

5. Either 2 plus 2 equals 22 or Santa Claus is real. But 2 plus 2 does not equal 22. Therefore, Santa Claus is real.

6. Either we use nuclear power or we reduce our consumption of energy. If we use nuclear power, then we place our lives at great risk. If we reduce our consumption of energy, then we place ourselves under extensive governmental control. So, either we place our lives at great risk or we place ourselves under extensive governmental control.

* 7. All birds are animals. No tree is a bird. Therefore, no tree is an animal.

8. Some humans are comatose. But no comatose being is rational. So, not every human is rational.

9. All animals are living things. At least one cabbage is a living thing. So, at least one cabbage is an animal.

* 10. Alvin likes Jane. Jane likes Chris. So, Alvin likes Chris.

11. All murderers are criminals. Therefore, all nonmurderers are noncriminals.

12. David is shorter than Saul. Saul is shorter than Goliath. It follows that David is shorter than Goliath.

* 13. It is possible that McGraw will win the next presidential election. It is possible that Lambert will win the next presidential election. Thus, it is possible that both McGraw and Lambert will win the next presidential election.

14. All physicians are singers. Lady Gaga is a physician. Therefore, Lady Gaga is a singer.

15. Samuel Morse invented the telegraph. Alexander Graham Bell did not invent the telegraph. Consequently, Morse is not identical with Bell.

PART D: Soundness Which of the following arguments are sound? Which are unsound? If an argument is unsound, explain why.

* **1.** All cats are mammals. All mammals are animals. So, all cats are animals.

2. All collies are dogs. Some animals are not dogs. So, some animals are not collies.

3. All citizens of Nebraska are Americans. All citizens of Montana are Americans. So, all citizens of Nebraska are citizens of Montana.

* **4.** "Let's party!" is either a sentence or a statement (or both). "Let's party!" is a sentence. So, "Let's party!" is not a statement.

5. No diamonds are emeralds. The Hope Diamond is a diamond. So, the Hope Diamond is not an emerald.

6. All planets are round. The earth is round. So, the earth is a planet.

* **7.** If the Taj Mahal is in Kentucky, then the Taj Mahal is in the U.S.A. But the Taj Mahal is not in the U.S.A. So, the Taj Mahal is not in Kentucky.

8. All women are married. Some executives are not married. So, some executives are not women.

9. All mammals are animals. No reptiles are mammals. So, no reptiles are animals.

* **10.** All mammals are cats. All cats are animals. So, all mammals are animals.

11. Wilbur Wright invented the airplane. Therefore, Orville Wright did not invent the airplane.

12. All collies are dogs. Hence, all dogs are collies.

* **13.** William Shakespeare wrote *Hamlet*. Leo Tolstoy is identical with William Shakespeare. It follows that Leo Tolstoy wrote *Hamlet*.

14. If San Francisco is in Saskatchewan, then San Francisco is in Canada. But it is not true that San Francisco is in Saskatchewan. Hence, it is not true that San Francisco is in Canada.

15. Either Thomas Jefferson was the first president of the U.S.A. or George Washington was the first president of the U.S.A., but not both. George Washington was the first president of the U.S.A. So, Thomas Jefferson was not the first president of the U.S.A.

1.2 Forms and Validity

Deductive logic is the study of methods for determining whether or not an argument is valid. This section introduces the concept of an argument form and explains how an understanding of argument forms can help establish the validity of an argument.

Argument Forms

Consider the following two arguments:

31. 1. If Pepé is a Chihuahua, then Pepé is a dog.
2. Pepé is a Chihuahua.
So, 3. Pepé is a dog.

32. 1. If Halle is a black actress, then Halle is a woman.
2. Halle is a black actress.
So, 3. Halle is a woman.

In each case, lines 1 and 2 are the premises and line 3 is the conclusion. Both of these arguments are valid: It is necessary that, if the premises are true, then the conclusion is true. Moreover, both of these arguments have the same *argument form,* where an **argument form** is simply a pattern of reasoning.

An **argument form** is a pattern of reasoning.

The particular form of reasoning exhibited by arguments (31) and (32) is so common that logicians have given it a special name: ***modus ponens,*** which means "the mode or way of positing." (Notice that, in each of them, the second premise posits or affirms the if-part of the first premise.) This pattern of reasoning can be represented as follows:

Modus Ponens

1. If A, then B.
2. A.
So, 3. B.

Here, the letters A and B are **variables** that stand in for statements. To illustrate how these variables work, suppose that we erase each appearance of A in the form above and write the same statement in both blanks (any statement will do). Next, suppose that we erase each appearance of B and write down the same statement in both blanks. We will then have a *substitution instance* of the argument form *modus ponens*. For example, if we replace each appearance of *A* with the statement "Pepé is a Chihuahua" and we replace each appearance of B with the statement "Pepé is a dog," we arrive at (31). Similarly, if we substitute "Halle is a black actress" for A and "Halle is a woman" for B, we are left with (32). Thus, both arguments are substitution instances of the argument form *modus ponens*. Generalizing, we can say that a **substitution instance** of an argument form is an argument that results from uniformly replacing the variables in that form with statements (or terms).*

A **substitution instance** of an argument form is an argument that results from uniformly replacing the variables in that form with statements (or terms).

We will look at further examples of argument forms and substitution instances in a moment. But let's first use the concepts to understand how an argument's validity can be entirely due to its form.

Consider the following argument:

33. 1. If A.J. Ayer is an emotivist, then A.J. Ayer is a noncognitivist.
2. A.J. Ayer is an emotivist.
So, 3. A.J. Ayer is a noncognitivist.

Argument (33), like (31) and (32), is an instance of *modus ponens* (it results from replacing A with "A.J. Ayer is an emotivist" and B with "A.J. Ayer is a noncognitivist"). Moreover, (33), like (31) and (32), is a valid argument. This much should be clear, even if some of the words in (33) are unfamiliar and even if one has no idea who A.J. Ayer is. Suppose it's true that A.J. Ayer is an emotivist (whatever that is). And suppose it's also true that, if A.J. Ayer is an emotivist, then he is a noncognitivist (whatever that is). Given those assumptions, it must follow that A.J. Ayer is a noncognitivist as well. That is just to say that it is impossible for the premises of (33) to be true while the conclusion is false. So, it is valid.

Arguments (31), (32), and (33) illustrate the fact that the validity of an argument that has the form of *modus ponens* is guaranteed by that form alone; its validity does not depend on its subject matter (or content). Hence, every substitution instance of *modus ponens* will be a valid argument no matter what its content happens to be. In this sense, *modus ponens* is a *valid argument form*. More generally, we can say that a **valid argument form** is one in which every substitution instance is a valid argument.

A **valid argument form** is one in which every substitution instance is a valid argument.

*The reader should ignore the parenthetical comment at this point. We will discuss forms that result from replacing terms, rather than statements, in section 1.3.

(Note that this is a definition of a valid *argument form*, which should not be confused with the definition of a valid *argument* from section 1.1.) The crucial point is this: It is no coincidence that all of the arguments we have looked at so far in section 1.2 are valid. They are valid because each of them is an instance of a valid argument form, namely *modus ponens*. In this sense, each of the arguments we have looked at is a *formally valid argument*, where a **formally valid argument** is one that is valid in virtue of its form.

A **formally valid argument** is one that is valid in virtue of its form.

Memorize *formally valid argument*.

While most valid arguments in ordinary life are formally valid, not every valid argument is formally valid. That is, some arguments are valid, but they are not valid in virtue of their form. For example, consider the following argument:

34. All philosophers are nerds. So, no squares are circles.

The conclusion of this argument is an example of what philosophers call a "necessary truth," because it *must* be true; that is, it is impossible for anything to be both a square and a circle at once. But if it is impossible for the conclusion to be false, then it is also impossible for the premise to be true while the conclusion is false. That is to say, it is impossible for all philosophers to be nerds while some squares are circles. Argument (34) is, therefore, valid. Its validity, however, has nothing to do with its form and everything to do with the content of its conclusion. Although (34) is unusual, it highlights the fact that an argument can be valid without being formally valid.

Even though an argument can be valid without being formally valid, the crucial point to grasp is that *if an argument is a substitution instance of a valid form, then the argument is valid*. Thus, if we determine an argument's form and see that the form is valid, we can establish that the argument is valid.

In the remainder of section 1.2, we will begin the task of learning to recognize argument forms, which we will continue in later chapters. For now, we will present five "famous" valid forms and then use them to provide an initial method for determining the validity of arguments. But before we get started, we must pause to make an important observation. If-then statements play an important role in many of the arguments and argument forms we will be looking at in this chapter and beyond. Consequently, it is worthwhile to discuss them in some detail before going on.

Understanding Conditional Statements

Each of the following is a **conditional statement** (an if-then statement, often simply called a ***conditional*** by logicians):

35. If it is snowing, then the mail will be late.
36. If Abraham Lincoln was born in 1709, then he was born before the American Civil War.
37. If Abraham Lincoln was born in 1947, then he was born after World War II.

Conditionals have several important characteristics. First, note their components. The if-clause of a conditional is called its **antecedent;** the then-clause is called the **consequent.** But the antecedent does not include the word "if." Hence, the antecedent of conditional (35) is "it is snowing," not "If it is snowing." Similarly, the consequent is the statement following the word "then," but it does not include that word. So, the consequent of (35) is "the mail will be late," not "then the mail will be late."

A **conditional statement** is an if-then statement—for example, "If A, then B"—often called a "conditional"; the if-part is the **antecedent** and the then-part is the **consequent**.

Second, conditionals are hypothetical in nature. Thus, in asserting a conditional, one does not assert that its antecedent is true. Nor does one assert that its consequent is true. Rather, one asserts that *if* the antecedent is true, *then* the consequent is true. Thus, (36) is true even though its antecedent is false (Lincoln was born in 1809, not 1709). If Lincoln was born in 1709, then, of course, his birth preceded the American Civil War, which began in 1861. And (37) is true even though its consequent is false. If Lincoln was in fact born in 1809, then he certainly was not born *after* World War II.

Third, there are many ways to express a conditional in ordinary English. Consider the following conditional statement:

38. If it is raining, then the ground is wet.

Statements (a) through (f) below are all **stylistic variants** of (38), that is, alternate ways of saying the very same thing[3]:

a. *Given that* it is raining, the ground is wet.
b. *Assuming that* it is raining, the ground is wet.
c. The ground is wet *if* it is raining.

d. The ground is wet *given that* it is raining.
e. The ground is wet *assuming that* it is raining.
f. It is raining *only if* the ground is wet.

Each of (a) through (f) says the very same thing as (38), so (38) can be substituted for each of them in an argument. And as we will see, making such substitutions is an aid to identifying argument forms. Accordingly, a close look at these stylistic variants is warranted. Consider (c). Note that "if" comes not at the beginning but in the middle of the statement. Yet, (c) has the same meaning as (38). And the phrase "given that" in (d) plays a role exactly analogous to the "if" in (c). We might generalize from these examples by saying that "if" and its stylistic variants (e.g., "given that" and "assuming that") *introduce an antecedent*. But we must hasten to add that this generalization does not apply when "if" is combined with other words, notably "only." When combined with "only," as in (f), the situation alters dramatically. Statement (f) has the same meaning as (38), but the phrase "only if" is confusing to many people and bears closer examination.

To clarify the meaning of "only if," it is helpful to consider very simple conditionals, such as the following:

39. Rex is a dog *only if* Rex is an animal.
40. Rex is an animal *only if* Rex is a dog.

Obviously, (39) and (40) say different things. (40) says, in effect, that if Rex is an animal, Rex is a dog. But (39) says something entirely different—namely, that if Rex is a dog, then Rex is an animal. In general, statements of the form *A only if B* say the same thing as statements of the form *If A, then B*. They do *not* say the same thing as statements of the form *If B, then A*. Another way to generalize the point is to say that "only if" (unlike "if") *introduces a consequent*.

To discern the form of an argument more easily, it is best to convert stylistic variants of conditionals into the standard *if-then* form. This will be our practice as we develop our methods for discerning the validity and invalidity of arguments.

We will have more to say about conditionals in later chapters. But what we have said here is enough to facilitate our discussion of famous valid argument forms and the method they provide for assessing the validity of arguments.

Famous Valid Forms

We have already been introduced to the first of our famous valid forms, *modus ponens*. We must now meet its sibling, *modus tollens*. Consider the following pair of arguments:

41. 1. If it is raining, then the ground is wet.
2. The ground is not wet.
So, 3. It is not raining.

42. 1. If there is fire in the room, then there is air in the room.
2. There is no air in the room.
So, 3. There is no fire in the room.

In each case, lines 1 and 2 are the premises and line 3 is the conclusion. Both arguments are clearly valid: It is necessary that, if the premises are true, the conclusion is true also. Moreover, each argument is formally valid: It is valid because it is an instance of the argument form *modus tollens,* which means "the mode or way of removing." (Notice that, in arguments (41) and (42), the second premise removes or denies the truth of the consequent of the first premise.) We can represent *modus tollens* as follows:

Modus Tollens

1. If A, then B.
2. Not B.
So, 3. Not A.

No matter what A and B are, the result will be a valid argument.

Modus tollens is related to *modus ponens*. They both have a premise that is a conditional statement. The key difference lies in the negative nature of the last two lines. "Not A" and "Not B" stand for *negations*. The **negation** of a statement is its denial. For example, in (41), "The ground is not wet" plays the role of Not B and "It is not raining" plays the role of Not A, while in (42), "There is no air in the room" plays the role of Not B and "There is no fire in the room" plays the role of Not A.

The **negation** of a statement is its denial—for example, "It is not the case that A."

The negation of a statement can be formed in various ways. For example, each of the following is a negation of the statement "The ground is wet":

a. *It is not the case that* the ground is wet.
b. *It's false that* the ground is wet.
c. *It is not true that* the ground is wet.
d. The ground is *not* wet.

Three general points can be illustrated with *modus ponens* and *modus tollens*. First, whether an argument is an instance of an argument form is not affected by the order of the premises. For example, both of the following count as *modus tollens:*

43. If Shakespeare was a physicist, then he was a scientist. Shakespeare was not a scientist. So, Shakespeare was not a physicist.

44. Shakespeare was not a scientist. If Shakespeare was a physicist, then he was a scientist. So, Shakespeare was not a physicist.

In other words, arguments of the form *Not B; if A, then B; so, Not A* count as instances of *modus tollens*. Similarly, arguments of the form *A; if A, then B; so, B* count as instances of *modus ponens*. In the remainder of this chapter, keep in mind that the general point here—that the order of the premises does not matter—applies to all of the argument forms that we will discuss.

Second, the conditionals involved in an argument can be rather long and complex. For example:

45. If every right can be waived in the interests of those who have those rights, then euthanasia is permitted in those cases in which the person to be "euthanized" waives his or her right to life. Moreover, every right can be waived in the interests of those who have those rights. Hence, euthanasia is permitted in those cases in which the person to be "euthanized" waives his or her right to life.

The conditional premise in this argument is relatively long and complex, but the form is still *modus ponens*. "Every right can be waived in the interests of those who have those rights" replaces A; "euthanasia is permitted in those cases in which the person to be euthanized waives his or her right to life" replaces B.

Third, putting an argument into explicit form helps to focus attention on the key issues. For example, according to some physicists who endorse the Big Bang theory, the universe cannot be infinitely old. The second law of thermodynamics tells us that in a closed physical system entropy always tends to increase; that is, energy gets diffused over time. (For instance, the radiant energy of a star will gradually become spread out evenly into the space surrounding it.) According to these physicists, if the physical universe has existed for an infinite period, there are now no concentrations of energy (e.g., no stars or planets). But obviously, there are stars and planets, so the physical universe has not existed for an infinite period. We can put this reasoning explicitly into the *modus tollens* form as follows:

46. 1. If the physical universe has existed for an infinite period, then all the energy in the universe is spread out evenly (as opposed to being concentrated in such bodies as planets and stars).
2. It is not true that all the energy in the universe is spread out evenly (as opposed to being concentrated in such bodies as planets and stars).
So, 3. It is not true that the physical universe has existed for an infinite period.

By putting the argument into explicit form, we are better able to focus our attention on the key issue. There is no debate whatsoever about the second premise of this argument. Stars and planets exist, so energy is not in fact spread out evenly throughout the physical universe. Nor is there any debate about the validity of the argument. Every argument having the form *modus tollens* is valid. The focus of the debate, therefore, must be on the first premise, and that is just where physicists have placed it. For example, some physicists think that the universe oscillates, that is, goes through a cycle of "Big Bangs" and "Big Crunches." And if the universe can oscillate, then its diffuse energy can be reconcentrated into usable forms, in which case the first premise is doubtful.[4]

Our third famous valid form is *hypothetical syllogism*. Consider the following argument:

47. 1. If tuition continues to increase, then only the wealthy will be able to afford a college education.
2. If only the wealthy will be able to afford a college education, then class divisions will be strengthened.
So, 3. If tuition continues to increase, then class divisions will be strengthened.

This is an instance of **hypothetical syllogism,** which we can represent as follows:

Hypothetical Syllogism

1. If A, then B.
2. If B, then C.
So, 3. If A, then C.

The argument form is called *hypothetical syllogism* because it involves only hypothetical (i.e., conditional) statements. *Syllogism* comes from the Greek roots meaning "to reason together" or to put statements together into a pattern of reasoning. Every argument that exemplifies this form is valid. For example:

> **48.** If I am morally responsible, then I can choose between good and evil. If I can choose between good and evil, then some of my actions are free. Therefore, if I am morally responsible, then some of my actions are free.

Note that the conclusion of a hypothetical syllogism is a conditional statement.

Thus far in this section, we have focused on argument forms that involve conditional statements. Not all argument forms are like this. Some use **disjunctions,** that is, statements of the form *Either A or B,* whose parts are called ***disjuncts.*** (For example, the disjuncts of "Either the Second Temple of Jerusalem was destroyed in 70 CE or my memory is failing me" are "the Second Temple of Jerusalem was destroyed in 70 CE" and "my memory is failing me.")

A **disjunction** is an either-or statement—for example, "Either A or B": the parts are **disjuncts**.

Now consider this pair of arguments:

49. 1. Either Pablo Picasso painted *Woman with a Guitar* or Georges Braque painted it.
2. Pablo Picasso did not paint *Woman with a Guitar*.
So, 3. Georges Braque painted *Woman with a Guitar.*

50. 1. Either experimentation on live animals should be banned or experimentation on humans should be permitted (e.g., the terminally ill).
2. Experimentation on humans should not be permitted.
So, 3. Experimentation on live animals should be banned.

Each of these arguments is valid. Each affirms a disjunction, denies one of the disjuncts, and then concludes that the remaining disjunct is true. They are each an instance of **disjunctive syllogism,** which comes in two versions:

Disjunctive Syllogism (in two versions)

1. Either A or B.	1. Either A or B.
2. Not A.	2. Not B.
So, 3. B.	So, 3. A.

Argument (49) is an instance of the first version; argument (50) is an instance of the second. All arguments of either version of disjunctive syllogism are valid.

Some brief remarks about disjunctions are in order here. First, we will take statements of the form *Either A or B* to mean *Either A or B (or both)*. This is called the **inclusive** sense of "or." For instance, suppose a job announcement reads: "Either applicants must have work experience or they must have a bachelor's degree in the field." Obviously, an applicant with *both* work experience *and* a bachelor's degree is not excluded from applying.

Second, some authors speak of an **exclusive** sense of "or," claiming that statements of the form *Either A or B* sometimes mean *Either A or B (but not both)*. For example, in commenting on a presidential election, one might say, "Either Smith will win the election or Jones will win," the assumption being that not both will win. However, it is a matter of controversy whether there really are two different meanings of the word "or" *as opposed to* there simply being cases in which the context indicates that A and B are not both true. Rather than let this controversy sidetrack us, let us simply assume with most logicians that statements of the form *Either A or B* mean *Either A or B (or both)*.

Third, having made this assumption, however, we must immediately add that arguers are free to use statements of the form *Either A or B (but not both)*. This is equivalent to the combination of two statements: *Either A or B, and not both A and B*. Consider the following argument:

51. Either Millard Fillmore was the thirteenth president of the U.S.A. or Zachary Taylor was the thirteenth president of the U.S.A. (but not both). Millard Fillmore was the thirteenth president. So, Zachary Taylor was not the thirteenth president.

We can represent the form of this argument as *Either A or B; not both A and B; A; so, not B*. This form is valid, but notice that it differs from disjunctive syllogism.

Fourth, note that disjunctive syllogism differs from the following form of argument:

52. Either Hitler was a Nazi or Himmler was a Nazi. Hitler was a Nazi. Therefore, it is not the case that Himmler was a Nazi.

The form of this argument can be best represented as *Either A or B; A; therefore, not B*. As a matter of historical fact, the premises of (52) are true, but its conclusion is false; therefore, this argument form is invalid, unlike disjunctive syllogism.

Let's look at one more famous valid argument form: **constructive dilemma.** It combines both conditional and disjunctive statements. Here is an example:

53. 1. Either Donna knew the information on her tax returns was inaccurate or her tax preparer made a mistake.
2. If Donna knew the information was inaccurate, she should pay the fine.
3. If her tax preparer made a mistake, then he should pay the fine.
So, 4. Either Donna should pay the fine or her tax preparer should pay the fine.

The form of this argument is as follows:

Constructive Dilemma

1. Either A or B.
2. If A, then C.
3. If B, then D.
So, 4. Either C or D.

Arguments of this form are always valid. The age-old problem of evil can be put in the form of a constructive dilemma:

54. Either God cannot prevent some suffering or God does not want to prevent any of it. If God cannot prevent some suffering, then God is weak. If God does not want to prevent any suffering, then God is not good. So, either God is weak or God is not good.

This dilemma nicely illustrates how logic can be used to formulate a problem in a revealing way. Because argument (54) is valid, it is not possible for all of the premises to be true and the conclusion false. Theists, against whom the argument is directed, can hardly deny the first (disjunctive) premise. (If God can prevent some suffering, then God must not want to do so for some reason.) And the second premise seems undeniable. (After all, even we can prevent some suffering.) Historically, the third premise has been the focus of debate, with theists suggesting that God does not want to eliminate any suffering because permitting it is the necessary means to certain good ends (e.g., the personal growth of free creatures).

The Famous Forms Method

At this point, we have introduced five famous valid argument forms, which are summarized in the following table:

Summary of Famous Valid Forms

Modus ponens: If A, then B. A. So, B.

Modus tollens: If A, then B. Not B. So, Not A.

Hypothetical syllogism: If A, then B. If B, then C. So, if A, then C.

Disjunctive syllogism (in two versions): Either A or B. Not A. So, B.
Either A or B. Not B. So, A.

Constructive dilemma: Either A or B. If A, then C. If B, then D. So, either C or D.

Memorize the five famous forms. They are crucial here *and later.*

We can now use these forms to determine the validity of many arguments, by employing the following method. Here's how.

Consider the following argument:

55. Pam is old *only if* she is over 80. But Pam is not over 80, and so she is not old.

First, we identify the component statements in the argument, uniformly labeling them with capital letters as we have throughout this section. To avoid errors, write the capital letter by each instance of the statement it stands for, taking negations into account, like this:

A *B* *not B*

55. Pam is old *only if* she is over 80. But Pam is not over 80, and so she is not old.

not A

Second, we rewrite the argument using capital letters instead of English statements and eliminate any stylistic variants (in this case, we replace "only if" with the standard "if . . . , then . . ." construction). The result is this:

1. If A, then B.
2. Not B.

So, 3. Not A.

Third, we check to see whether the form is taken from our list of famous valid forms. In this case, it is *modus tollens,* so we conclude that argument (55) is valid.

Let's call the method just indicated the **famous forms method.** Here it is in action again. Consider the following argument:

56. If Andrew knows he has a piano, then he knows he is outside the Matrix. Andrew knows he has a piano. So, Andrew knows he is outside the Matrix.

First, we identify and label the component statements in the argument, uniformly labeling them as follows:

A B
56. If Andrew knows he has a piano, then he knows he is outside the Matrix. Andrew knows he has a piano. So, Andrew knows he is outside the Matrix.
A B

Next, we rewrite the argument using capital letters instead of English statements and eliminate any stylistic variants, arriving at this form:

1. If A, then B.
2. A.

So, 3. B.

Finally, we ask whether this form is one of our famous valid forms. In this case, it is *modus ponens*. Thus, argument (56) is valid.

The Famous Forms Method

Step 1. Identify the component statements in the argument, uniformly labeling each with a capital letter.

Step 2. Rewrite the argument using capital letters instead of English statements and eliminate any stylistic variants.

Step 3. Check to see whether the pattern of reasoning is taken from our list of famous forms. If it is, then the argument is valid.

It will be helpful at this time to highlight a complication of the famous forms method. It can be seen by considering the following argument:

A B
57. Frances is a fast runner *if* she can run the mile in under four minutes. Frances can run the mile in under four minutes. Therefore, Frances is a fast runner.
B A

When we rewrite the argument using capital letters and eliminate stylistic variants, we get this form:

1. If B, then A.
2. B.

So, 3. A.

Our labeling results in *If B, then A* rather than *If A, then B*. But this is not a problem. There is no need to try to make the letters appear in alphabetical order. The important thing is that the second premise affirms the antecedent of the conditional premise, while the conclusion affirms the consequent. Thus, we have an instance of *modus ponens,* and the argument is valid.

It is now time to acknowledge two limitations of the famous forms method. The first one can be seen through arguments like this:

58. Fred likes neckerchiefs. Daphne likes neckerchiefs. So, Fred likes neckerchiefs and Daphne likes neckerchiefs.

Even though this argument is trivial, it is formally valid. It is an instance of this valid argument form:

Form 1

1. A.
2. B.

So, 3. A and B.

It is not possible for the conclusion, A and B, to be false while the premises, A and B, are true. The problem is that this valid form is not a famous form from our list, so the famous forms method does not tell us that (58) is valid. Similarly, in our discussion of disjunctions, we noted that the form of argument (51) was this:

Form 2

1. Either A or B.
2. Not both A and B.
3. A.

So, 4. Not B.

Form 2 is valid, but it is not on our list. This is a genuine limitation of the famous forms method. Although it is true that *many* valid arguments are instances of our five famous valid forms, there are also many other formally valid arguments, like arguments (51) and (58), that are not. Hence, the fact that the famous forms method does not show that an argument is formally valid does not mean that it is not formally valid. Of course, we could deal with this problem by adding Forms 1 and 2 to our list. While this solution contains a grain of wisdom (in essence, the proof systems we develop later are built on this insight), we would have to add infinitely many forms to cover all the possible valid forms, a daunting task indeed.

A second limitation of the famous forms method is that it does *nothing* to help us show that any invalid argument is invalid. It is concerned only with showing the validity of arguments.

If the famous forms method suffers from these limitations, why bother learning it? Well, despite its limitations, we should not lose sight of the fact that the famous forms method is simple, straightforward, and all that is needed in many cases. Moreover, understanding it and its limitations constitutes an important first step toward grasping some basic logical concepts and appreciating more complete methods for assessing arguments.

Summary of Definitions

An **argument form** is a pattern of reasoning.

A **substitution instance** of an argument form is an argument that results from uniformly replacing the variables in that form with statements (or terms).

A **valid argument form** is one in which every substitution instance is a valid argument.

A **formally valid argument** is one that is valid in virtue of its form.

The **negation** of a statement is its denial.

A **conditional statement** is an if-then statement, often simply called a "conditional."

The if-clause of a conditional is its **antecedent**.

The then-clause of a conditional is its **consequent**.

A **disjunction** is an either-or statement.

The statements comprising a disjunction are its **disjuncts**.

EXERCISE 1.2

PART A: True or False? Which of the following statements are true? Which are false?

* **1.** A substitution instance of an argument form is an argument that results from uniformly replacing the variables in that form with statements (or terms).

2. A conditional is an "if-then" statement.

3. The parts of a disjunction are disjuncts.

* **4.** In logic, we treat statements of the form "Either A or B" as saying the same thing as "Either A or B, but not both A and B."

5. The if-part of a conditional is the antecedent.

6. A valid argument form is one in which every substitution instance is a valid argument.

* **7.** The consequent of "If it was reported in the *Daily Prophet,* then it's true" is "It was reported in the *Daily Prophet.*"

8. In logic, we treat statements of the form "Either A or B" as saying the same thing as "Either A or B, or both A and B."

9. "Either Hermione gets Ron or she gets Harry" is a conditional.

* **10.** The inclusive sense of "or" means "Either A or B, or both."

11. "Either Fritz is a philosopher or he is a gambler" is a disjunction.

12. An argument form is a pattern of reasoning.

* **13.** The then-part of a conditional is the consequent.

14. If the successful candidate has a PhD in English literature or at least five years of university teaching experience, it follows that the successful candidate does not have both a PhD in English literature and at least five years of university teaching experience.

15. The antecedent of "If Professor Dumbledore died in Book Six, then he won't make an appearance in Book Seven" is "Professor Dumbledore died in Book Six."

* **16.** The negation of a statement is its denial.

17. A formally valid argument is one that is valid in virtue of its form.

18. The antecedent of "If Professor Snape was a disciple of Voldemort, then he should be imprisoned in Azkaban" is "He should be imprisoned in Azkaban."

* **19.** The consequent of "If Dolores Umbrage despises Harry, then she's a disciple of he-who-shall-not-be-named" is "She's a disciple of he-who-shall-not-be-named."

20. A disjunction is an "either-or" statement.

21. "There is no God" is the denial of "There is a God."

* 22. The exclusive sense of "or" means "Either A or B, but not both."

23. In determining whether an argument is a substitution instance of an argument form, we must be careful to take the order of the premises into account.

24. The antecedent of "Either humans evolved from amoebas or humans were specially created by God" is "Humans evolved from amoebas."

* 25. The antecedent of "The Sonics will move to Oklahoma only if the league permits it" is "The Sonics will move to Oklahoma."

26. The antecedent of "Bill will behave better in the future if Hillary forgives Bill" is "Bill will behave better in the future."

27. The consequent of "There is air in the room if there is fire in the room" is "There is air in the room."

* 28. The following argument is a substitution instance of disjunctive syllogism: "Jill is in love with Sam or Henry; she is in love with Henry; so Jill is not in love with Sam."

29. Although the famous forms method does not allow us to show that an argument is invalid, it does allow us to show the validity of every valid argument.

30. The consequent of "There is fire in the room *only if* there is air in the room" is "There is air in the room."

PART B: Identify the Forms Write out the forms of the following arguments, using capital letters to stand for statements and eliminating any stylistic variants. If the argument form is one of the "famous" valid forms, give its name. If the argument form is not one of the "famous" valid forms, write "none."

* 1. If the solution turns blue litmus paper red, then the solution contains acid. The solution turns blue litmus paper red. So, the solution contains acid.

2. If the solution turns blue litmus paper red, then the solution contains acid. The solution does not contain acid. So, the solution does not turn blue litmus paper red.

3. Lewis is a famous author only if he knows how to write. But Lewis is not a famous author. Hence, Lewis does not know how to write.

* 4. If Susan is a famous author, then she knows how to write. Moreover, Susan knows how to write. So, she is a famous author.

5. Souls transmigrate. But it is wrong to eat animals if souls transmigrate. Hence, it is wrong to eat animals.