PART 2 MODULE 2
THE CONDITIONAL STATEMENT AND ITS VARIATIONS

THE CONDITIONAL STATEMENT
A **conditional** statement is a statement of the form "If p, then q."
The symbol for this "if...then" connective is the arrow: →
That is, the statement "if p, then q" is denoted p→q

EXAMPLE 2.2.1
Let p represent "You drink Pepsi."
Let q represent "You are happy."
In this case p→q is the statement: "If you drink Pepsi, then you are happy."

TERMINOLOGY
"You drink Pepsi" is called the **antecedent.**
"You are happy" is called the **consequent.**
More generally, the antecedent is associated with the "if" part of a conditional statement, while the consequent is associated with the "then" part of a conditional statement.

EXAMPLE 2.2.2
Let p be the statement "It rains."
Let q be the statement "I stay home."
Symbolize each statement.
1. If it rains, then I stay home.
2. It is not the case that if it rains, then I stay home.
3. If I don't stay home, then it doesn't rain.
4. It is not the case that if I stay home, then it doesn't rain.

Solutions to EXAMPLE 2.2.2
1. p→q
2. ~(p→q) Note that in this case it is the entire "if…then" statement, rather than just one or both of its components, than is being negated.
3. ~q→~p
4. ~(q→~p)

For any conditional statement there are several other similar-sounding conditional statements. Some of these variations have special names.

VARIATIONS ON THE CONDITIONAL STATEMENT

Direct statement	**Converse**	**Inverse**	**Contrapositive**
If p, then q.	If q, then p.	If not p, then not q.	If not q, then not p.
p→q	q→p	~p→~q	~q→~p

EXAMPLES
Direct statement: *If you drink Pepsi, then you are happy.*
Converse: *If you are happy, then you drink Pepsi.*
Inverse: *If you don't drink Pepsi, then you aren't happy.*
Contrapositive: *If you aren't happy, then you don't drink Pepsi.*

EXAMPLE 2.2.3
Symbolize this statement, taken from the instructions for IRS From 1040, line 10:
If you received a refund of state income taxes or you received a refund of local income taxes, then, if your itemized deduction of state income taxes resulted in a tax benefit or your itemized deduction of local income taxes resulted in a tax benefit, then you must report this tax benefit as income.
Let
p: you received a refund of state income taxes
q: you received a refund of local income taxes
r: your itemized deduction of state income taxes resulted in a tax benefit
s: your itemized deduction of local income taxes resulted in a tax benefit
w: you must report this tax benefit as income

World Wide Web Note
For practice problems involving translation of statements from words into symbols and vice-versa, visit the companion website and try THE SYMBOLIZER
EXAMPLE 2.2.4
Let p be the statement "You drink Pepsi."
Let q be the statement "You are happy."
Make a truth table for the statement $p \rightarrow q$.

The solution to the previous example illustrates the following:

FUNDAMENTAL PRPOERTY OF THE CONDITIONAL STATEMENT
The only situation in which a conditional statement is FALSE is when the ANTECEDENT is TRUE while the CONSEQUENT is FALSE.

EXAMPLE 2.2.5
1. Let p represent a true statement, while q and r represent false statements. Determine the truth value of this compound statement: $(p \rightarrow \sim q) \vee r$

2. Let p, s, and w represent true statements, while q, r and u represent false statements. Determine the truth value of this compound statement:
$\sim p \rightarrow \{\sim[(q \vee \sim r) \wedge (w \wedge \sim q) \vee [u \vee \sim w]]\}$

Hint for problem #2: This particular problem is not as complicated as it at first appears to be.

World Wide Web Note
For practice problems involving truth values of symbolic statements, visit the companion website and try THE LOGICIZER.

EXAMPLE 2.2.6
Complete the following truth table.

p	q	~p	~q	~p∧q	p→~q	(~p∧q)→q	(p→~q)∨(~p∧q)
T	T	F	F				
T	F	F	T				
F	T	T	F				
F	F	T	T				

World Wide Web Note
For practice problems involving truth tables, visit the companion website home page and try THE TRUTH TABLER.

A FACT ABOUT EQUIVALENCY
"If p, then q" is logically equivalent to "not p, or q"
Symbolically: $p \rightarrow q \equiv \sim p \vee q$

We can use a truth table to verify this claim.

p	q	~p	p→q	~p∨q
T	T	F	T	T
T	F	F	F	F
F	T	T	T	T
F	F	T	T	T

EXAMPLE 2.2.7
Select that statement that is logically equivalent to: "If you don't carry an umbrella, you'll get soaked."
A. You carry an umbrella and you won't get soaked.
B. You carry an umbrella or you get soaked.
C. You don't carry an umbrella and you get soaked.
D. You don't carry an umbrella or you get soaked.
E. You leave your umbrella in the classroom, so you get soaked anyway.

THE NEGATION OF THE CONDITIONAL STATEMENT
*The **negation** of "if p, then q" is "p, and not q"*
Symbolically: $\sim(p \rightarrow q) \equiv p \wedge \sim q$

We can use a truth table to verify this claim.

p	q	~q	p→q	~(p→q)	p∧~q
T	T	F	T	F	F
T	F	T	F	T	T
F	T	F	T	F	F
F	F	T	T	F	F

EXAMPLE 2.2.8

1. Select the statement that is the negation of "If you know the password, then you can get in."

A. If you don't know the password, then you can get in.
B. You don't know the password or you can get in.
C. You don't know the password and you can't get in.
D. You know the password and you can't get in.

2. Select the statement that is logically equivalent to "If you pass MGF1106, then a liberal studies math requirement is fulfilled."

A. If a liberal studies math requirement is fulfilled, then you passed MGF1106.
B. You pass MGF1106 and a liberal studies math requirement is fulfilled.
C. You don't pass MGF1106, or a liberal studies math requirement is fulfilled.
D. You pass MGF1106, or a liberal studies math requirement is not fulfilled.

3. Select the statement that is the negation of "If you have income from royalties, then you must complete Schedule E."

A. You have income from royalties and you must complete Schedule E.
B. You have income from royalties and you don't have to complete Schedule E.
C. You have income from royalties or you must complete Schedule E.
D. You have income from royalties or you don't have to complete Schedule E.

EXAMPLE 2.2.9

1. Select the statement that is the negation of "If we get a pay raise, then we will be content."

A. If we don't get a pay raise, then we won't be content.
B. We get a pay raise and we are content.
C. We get a pay raise and we aren't content.
D. We don't get a pay raise or we aren't content.

2. Select the statement that is logically equivalent to "If it is raining, then we will watch TV."

A. It isn't raining or we don't watch TV.
B. It isn't raining or we watch TV.
C. It is raining and we watch TV.
D. It is raining and we don't watch TV.
E. It is not safe to watch TV in the rain.

3. Select the statement that is the negation of "If a dog wags its tail, then it won't bite."

A. A dog wags its tail and it bites.
B. A dog wags its tail and it doesn't bite.
C. A dog doesn't wag its tail or it bites.

D. If a dog doesn't wag its tail, then it will bite.

SOME INFORMAL EQUIVALENCIES FOR THE CONDITIONAL STATEMENT
"**If p, then q**" is equivalent to "**All p are q**."
"**If p, then not q**" is equivalent to "**No p are q**."

For example,
"If something is a poodle, then it is a dog" is a round-about way of saying "All poodles are dogs."

Likewise,
"If something is a dog, then it isn't a cat" means the same as "No dogs are cats."

EXAMPLE 2.2.10
1. Select the statement that is the **converse** of "If I had a hammer, I would hammer in the morning."
A. If I didn't have a hammer, I wouldn't hammer in the morning."
B. If I don't hammer in the morning, I don't have a hammer.
C. If I hammer in the morning, I have a hammer.
D. If I had a ham, I would eat ham in the morning.

2. Select the statement that is the **inverse** of "If it rains, then I won't go to class."
A. If I don't go to class, then it rains.
B. If it doesn't rain, then I will go to class.
C. If I go to class, then it isn't raining.
D. Since it's Friday I probably won't go to class, anyway.

3. From Shakespeare (*Henry IV, Part II*): Select the statement that is the **negation** of this line, spoken by Falstaff addressing Doll Tearsheet: "If the cook help [sic] to make the gluttony, you help to make the diseases."
A. If the cook doesn't help to make the gluttony, you don't help to make the diseases.
B. If you help to make the diseases, the cook helps to make the gluttony.
C. If you don't help to make the diseases, the cook doesn't help to make the gluttony .
D. The cook helps to make the gluttony and you don't help to make the diseases.

FACTS ABOUT CONVERSE-INVERSE-CONTRAPOSITIVE
The **direct statement** is equivalent to the **contrapositive**.
$p \rightarrow q \equiv \sim q \rightarrow \sim p$

The **converse** is equivalent to the **inverse**.
$q \rightarrow p \equiv \sim p \rightarrow \sim q$

However, **the converse is NOT equivalent to the direct statement** and **the inverse is NOT equivalent to the direct statement**.

These claims can be verified by using truth tables.
If you make a truth table having columns for all four statements listed above you will see, for instance, that the column for $p \rightarrow q$ is identical to the column for $\sim q \rightarrow \sim p$, but these two columns are different from the column for $q \rightarrow p$ and different from the column for $\sim p \rightarrow \sim q$. However, the column for $q \rightarrow p$ will be identical to the column for $\sim p \rightarrow \sim q$.

EXAMPLE 2.2.11
1. Select the statement that is logically **equivalent** to "If today is Sunday, then school is closed."
A. If today isn't Sunday, then school isn't closed.
B. If school is closed, then today is Sunday.
C. If school isn't closed, then today isn't Sunday.
D. A, B, & C are all equivalent to the statement above.

2. Select the statement that is logically equivalent to "If you are a duck, then you aren't willing to waltz." (Adapted from Lewis Carrol.)
A. If you aren't willing to waltz, then you are a duck.
B. If you aren't a duck, then you are willing to waltz.
C. If you are willing to waltz, then you aren't a duck.
D. A, B & C are all equivalent to the given statement.

3. Select the statement that is NOT equivalent to "If I don't invest wisely, then I'll lose my money."
A. I invest wisely or I lose my money.
B. If I don't lose my money, then I invested wisely.
C. I lose my money or I invest wisely.
D. If I invest wisely, then I won't lose my money.

World Wide Web Note
For practice problems involving negations, equivalencies, DeMorgan's Laws and variations on the conditional statement, visit the companion website and try THE IMPLICATOR.

EXAMPLE 2.2.12
Select the statement that is logically equivalent to:
"If all of my friends got hired, then some losers are gainfully employed."
A. If some losers are not gainfully employed, then none of my friends got hired.
B. If no losers are gainfully employed, then some of my friends didn't get hired.
C. If some of my friends didn't get hired, then no losers are gainfully employed.
D. If none of my friends got hired, then some losers aren't gainfully employed.

EXAMPLE 2.2.13
A passage from Lewis Carroll:
"And now, if e'er by chance I put
My fingers into glue,
Or madly squeeze a right-hand foot
Into a left-hand shoe,
Or if I drop upon my toe
A very heavy weight,
I weep,for it reminds me so
Of that old man I used to know ..."

Select the statement that is equivalent to "If I put my fingers into glue or squeeze a right-hand foot into a left-hand shoe or drop a heavy weight upon my toe, then I weep."

A. If I don't weep then I don't put my fingers into glue or squeeze a right-hand foot into a left-hand shoe or drop a heavy weight upon my toe.
B. I put my fingers into glue or squeeze a right-hand foot into a left-hand shoe or drop a heavy weight upon my toe and I don't weep.
C. I don't put my fingers into glue and I don't squeeze a right-hand foot into a left-hand shoe and I don't drop a heavy weight upon my toe, or I weep.
D. If I weep, then I put my fingers into glue or squeeze a right-hand foot into a left-hand shoe or drop a heavy weight upon my toe.

EXAMPLE 2.2.14
"I didn't know I was to have a party at all," said Alice; "but if there is to be one, I think I ought to invite the guests."
Select the statement that is the negation of "I didn't know I would have a party, but if I will have a party I will choose the guests."
A. I knew I would have a party and if I won't have a party then I won't choose the guests.
B. I knew I would have a party or, I will have a party but I won't choose the guests.
C. I knew I would have a party or if I won't have a party then I won't choose the guests.
D. I knew I would have a party and, I will have a party but I won't choose the guests.

PRACTICE EXERCISES

1. Suppose p is the statement 'You eat carrots' and q is the statement 'You have good eyesight.' Select the correct statement corresponding to the symbols $\sim(p \rightarrow q)$.
A. You don't eat carrots or you have good eyesight.
B. If you don't eat carrots then you have good eyesight.
C. It is not the case that if you eat carrots then you have good eyesight.
D. It is not the case that either you eat carrots or you have good eyesight.

2. Suppose p is the statement 'I pass my math course' and q is the statement 'I will change my major to nuclear physics.' Select the correct statement corresponding to the symbols $\sim p \rightarrow q$.
A. It is not the case that if I pass my math course then I will change my major to nuclear physics.
B. It is not the case that either I pass my math course or I will change my major to nuclear physics.
C. I don't pass my math course and I will change my major to nuclear physics.
D. None of these.

3. Suppose p is the statement 'You get a speeding ticket' and q is the statement 'Your insurance rate goes up.' Select the correct symbolization for the statement 'If your insurance rate doesn't go up then you don't get a speeding ticket'.
A. $\sim p \rightarrow \sim q$ B. $\sim q \wedge \sim p$ C. $\sim q \rightarrow \sim p$ D. None of these

4. Suppose p is true, q is false, s is true. Find the truth value of $(\sim s \wedge p) \rightarrow (\sim q \rightarrow s)$
5. Suppose p is true, q is true, s is false. Find the truth value of $\sim[(s \rightarrow \sim p) \rightarrow (\sim q \rightarrow s)]$
6. Suppose p is false, q is true, r is true, s is false. Find the truth value of $(\sim p \wedge q) \rightarrow (r \rightarrow s)$
7. Suppose p is false, q is true, s is true. Find the truth value of $(\sim p \vee q) \rightarrow (q \vee s)$
8. Suppose p is false, q is true, r is true, s is true. Find the truth value of $(p \rightarrow q) \vee (r \vee \sim s)$
9. Suppose p is false, q is true, s is false. Find the truth value of $\sim[(s \rightarrow \sim p) \vee (\sim q \rightarrow \sim s)]$

10-18: Make a truth table for the given statement.

10. $(\sim p \vee \sim q) \rightarrow \sim(\sim p \vee r)$ **11.** $(p \wedge q) \rightarrow (\sim p \rightarrow q)$ **12.** $\sim[(\sim p \vee \sim q) \rightarrow p]$
13. $(p \wedge q) \rightarrow (p \rightarrow q)$ **14.** $(\sim p \vee q) \rightarrow \sim q$ **15.** $(p \vee q) \rightarrow \sim r$
16. $\sim[(\sim p \wedge \sim q) \rightarrow q]$ **17.** $(\sim p \wedge \sim q) \rightarrow r$ **18.** $\sim[(\sim p \wedge q) \rightarrow p]$

19-23: Decide whether the given statement is true or false.

19. True or false: $(p \wedge q) \rightarrow (\sim p \rightarrow q)$ is a tautology. *Hint: refer to the answer to #11 above.*
20. True or false: $\sim p \rightarrow q \equiv (\sim p \wedge \sim q) \rightarrow q$ *Hint: refer to the answers to #11 and #16 above.*
21. True or false: $(\sim p \wedge \sim q) \rightarrow r$ is a tautology. *Hint: refer to the answer to #17 above.*
22. True or false: $(\sim p \vee q) \rightarrow \sim q \equiv \sim[(\sim p \vee \sim q) \rightarrow p]$ *Hint: refer to the answers to #14 and #12 above.*
23. True or false: $(\sim p \vee q) \rightarrow \sim q$ is a tautology. *Hint: refer to the answer to #14 above.*

24. Select the statement that is the **negation** of "If you are a fish, then you have cold lips."
A. You are a fish and you don't have cold lips.
B. You are a fish or you don't have cold lips.
C. You aren't a fish or you have cold lips.
D. If you aren't a fish, then you don't have cold lips.

25. Select the statement that is **logically equivalent** to "Class is cancelled or this is not my lucky day."
A. Class is cancelled and this is not my lucky day.
B. Class is not cancelled and this is my lucky day.
C. Class is not cancelled or this is my lucky day.
D. If class is not cancelled then this is not my lucky day.

26. Select the statement that is **logically equivalent** to "If an offer sounds too good to be true, then I'm interested."
A. An offer sounds too good to be true or I'm interested.
B. An offer doesn't sound too good to be true, or I'm interested.
C. An offer sounds too good to be true and I'm not interested.
D. If I'm interested in an offer, then it sounds too good to be true.

27. Select the statement that is the **negation** of "If my computer breaks, then I won't be able to waste so much paper."
A. If my computer doesn't break then I will be able to waste so much paper.
B. My computer breaks and I am able to waste so much paper.
C. My computer doesn't break or I am able to waste so much paper.
D. If I am able to waste so much paper, then my computer didn't break.

28. Select the statement that is **logically equivalent** to "If you want to be on my team, then you like getting bossed around."
A. If you don't like getting bossed around, then you don't want to be on my team.
B. If you don't want to be on my team, then you don't like getting bossed around.
C. If you like getting bossed around, then you want to be on my team.
D. A, B, & C are all correct.
E. Stop whining and get to work.

29. Select the statement that is the **negation** of "Some of us don't have our textbooks."
A. None of us have our textbooks.
B. Some of us have our textbooks.
C. All of us have our textbooks.
D. We have this website instead.

30. Select the statement that is **logically equivalent** to "If you have passed MAC4411, then you can't receive credit for MGF1106."
A. You haven't passed MAC4411 or you can't receive credit for MGF1106.
B. If you can receive credit for MGF1106, then you haven't passed MAC4411.
C. All of those who have passed MAC4411 are ineligible to receive credit for MGF1106.
D. A, B and C are all correct.

31. Select the statement that is **logically equivalent** to "You can pick your friends or you can pick your nose."
A. You can't pick your friends and you can't pick your nose.
B. You can't pick your friends or you can't pick your nose.
C. If you can't pick your friends then you can pick your nose.
D. ...but you can't pick your friend's nose.

32. Select the statement that is **logically equivalent** to "If you eat that day-old burrito, you will use lots of hot sauce."
A. If you didn't use lots of hot sauce, then you didn't eat that day-old burrito.
B. If you don't eat that day-old burrito, then you won't use lots of hot sauce.
C. If you used lots of hot sauce, then you ate that day-old burrito.
D. A, B, & C are all equivalent to the given statement.

33. Select the statement that is the **negation** of
"All bulldogs are sweet and some poodles are mean."
A. No bulldogs are sweet and some poodles aren't mean.
B. No bulldogs are sweet or some poodles aren't mean.
C. Some bulldogs aren't sweet and no poodles are mean.
D. Some bulldogs aren't sweet or no poodles are mean.

34. Select the statement that is the **negation** of "If some bees fly into your face, then all of your plans for the day are ruined."
A. If no bees fly into your face, then all of your plans for the day are ruined.
B. If some bees fly into your face, then some of your plans for the day aren't ruined.
C. Some bees fly into your face and some of your plans for the day aren't ruined.
D. No bees fly into your face and none of your plans for the day are ruined.

35. Select the statement that is **logically equivalent** to
"If all of us are OK, then all of them are losers."
A. If all of them are losers, then all of us are OK.
B. Some of us are OK and all of them are losers.
C. If some of them aren't losers, then some of us aren't OK.
D. If some of us aren't OK, then some of them aren't losers.

36. Select the statement that is **logically equivalent** to
"If I lock my cat in the house, then she beats up the dog."
A. I lock my cat in the house and she doesn't beat up the dog.
B. I don't lock my cat in the house or she beats up the dog.
C. If I don't lock my cat in the house, then she doesn't beat up the dog.
D. None of these.

37. Select the statement that is the **negation** of
"If all things are considered, then I listen to public radio."
A. If I don't listen to public radio, then some things aren't considered.
B. If all things are considered then I don't listen to public radio.
C. Some things aren't considered or I listen to public radio.
D. All things are considered and I don't listen to public radio.

38. Select the statement that is **logically equivalent** to "We make a first down or we punt."
A. If we don't make a first down, then we punt.
B. We punt or we make a first down.
C. Both A & B.
D. None of these.

39. Select the statement that is the **negation** of "No campaign promises are sincere."
A. Some campaign promises are sincere.
B. Some campiagn promises are insincere.
C. All campaign promises are insincere.
D. All camping prom roses are sinister.

40. Select the statement that is logically **equivalent** to "No elephants are forgetful."
A. If you aren't an elephant, then you are forgetful.
B. If you are an elephant, then you aren't forgetful.
C. If you aren't forgetful, then you are an elephant.
D. All of these.

41. Referring to #28, select the **converse** of the given statement.

42. Referring to #30, select the **contrapositive** of the given statement.

43. Referring to #37, select the **contrapositive** of the given statement.

44. Referring to #35, select the **inverse** of the given statement.

45. Select the statement that is **equivalent** to "No beggars are choosers."
A. If you aren't a beggar, then you are a chooser.
B. All beggars are choosers.
C. If one is a beggar, then one isn't a chooser.
D. One is a beggar and one isn't a chooser.

46. Referring to #32, select the **inverse** of the given statement.

ANSWERS TO LINKED EXAMPLES

EXAMPLE 2.2.3 $(p \vee q) \rightarrow [(r \vee s) \rightarrow w]$

EXAMPLE 2.2.4

p	q	p→q
T	T	T
T	F	F
F	T	T
F	F	T

EXAMPLE 2.2.5 1. T 2. T

EXAMPLE 2.2.6

p	q	~p	~q	~p∧q	p→~q	(~p∧q)→q	(p→~q)∨(~p∧q)
T	T	F	F	F	F	T	F
T	F	F	T	F	T	T	T
F	T	T	F	T	T	T	T
F	F	T	T	F	T	T	T

EXAMPLE 2.2.7 B

EXAMPLE 2.2.8 1. D 2. C 3. B

EXAMPLE 2.2.9 1. C 2. B 3. A

EXAMPLE 2.2.10 1. C 2. B 3. D

EXAMPLE 2.2.11 1. C 2. C 3. D

EXAMPLE 2.2.12 B

EXAMPLE 2.2.13 C

EXAMPLE 2.2.14 D

ANSWERS TO PRACTICE EXERCISES

1. C **2.** D **3.** C

4. Suppose p is true, q is false, s is true. Then $(\sim s \wedge p) \rightarrow (\sim q \rightarrow s)$ is T.

5. Suppose p is true, q is true, s is false. Then $\sim[(s \rightarrow \sim p) \rightarrow (\sim q \rightarrow s)]$ is F.

6. Suppose p is false, q is true, r is true, s is false. Then $(\sim p \wedge q) \rightarrow (r \rightarrow s)$ is F.

7. Suppose p is false, q is true, s is true. Then $(\sim p \vee q) \rightarrow (q \vee s)$ is T.

8. Suppose p is false, q is true, r is true, s is true. Then $(p \rightarrow q) \vee (r \vee \sim s)$ is T.

9. Suppose p is false, q is true, s is false. Then $\sim[(s \rightarrow \sim p) \vee (\sim q \rightarrow \sim s)]$ is F.

10. (~p∨~q) → ~(~p∨r)

p	q	r	~p	~q	~r	~p ∨~q	~p ∨r	~(~p ∨r)	(~p ∨~q) →~(~p ∨r)
T	T	T	F	F	F	F	T	F	T
T	T	F	F	F	T	F	F	T	T
T	F	T	F	T	F	T	T	F	F
T	F	F	F	T	T	T	F	T	T
F	T	T	T	F	F	T	T	F	F
F	T	F	T	F	T	T	T	F	F
F	F	T	T	T	F	T	T	F	F
F	F	F	T	T	T	T	T	F	F

11. (p∧q) → (~p →q)

p	q	~p	~q	p ∧q	~p →q	(p ∧q) →(~p →q)
T	T	F	F	T	T	T
T	F	F	T	F	T	T
F	T	T	F	F	T	T
F	F	T	T	F	F	T

12. ~[(~p∨~q) → p]

p	q	~p	~q	~p ∨~q	(~p ∨~q) →(p)	~[(~p ∨~q) →(p)]
T	T	F	F	F	T	F
T	F	F	T	T	T	F
F	T	T	F	T	F	T
F	F	T	T	T	F	T

13. (p∧q) → (p→q)

p	q	~p	~q	p ∧q	p →q	(p ∧q) →(p →q)
T	T	F	F	T	T	T
T	F	F	T	F	F	T
F	T	T	F	F	T	T
F	F	T	T	F	T	T

14. (~p∨q) → ~q

p	q	~p	~q	~p ∨q	(~p ∨q) →~q
T	T	F	F	T	F
T	F	F	T	F	T
F	T	T	F	T	F
F	F	T	T	T	T

15. (p∨q) → ~r

p	q	r	~p	~q	~r	p ∨q	(p ∨q) →~r
T	T	T	F	F	F	T	F
T	T	F	F	F	T	T	T
T	F	T	F	T	F	T	F
T	F	F	F	T	T	T	T
F	T	T	T	F	F	T	F
F	T	F	T	F	T	T	T
F	F	T	T	T	F	F	T
F	F	F	T	T	T	F	T

16. ~[(~p∧~q) → q]

p	q	~p	~q	~p ∧~q	(~p ∧~q) →(q)	~[(~p ∧~q) →(q)]
T	T	F	F	F	T	F
T	F	F	T	F	T	F
F	T	T	F	F	T	F
F	F	T	T	T	F	T

17. (~p∧~q) → r

p	q	r	~p	~q	~r	~p ∧ ~q	(~p ∧ ~q) → r
T	T	T	F	F	F	F	T
T	T	F	F	F	T	F	T
T	F	T	F	T	F	F	T
T	F	F	F	T	T	F	T
F	T	T	T	F	F	F	T
F	T	F	T	F	T	F	T
F	F	T	T	T	F	T	T
F	F	F	T	T	T	T	F

18. ~[(~p∧q) → p]

p	q	~p	~q	~p ∧ q	(~p ∧ q) → (p)	~[(~p ∧ q) → (p)]
T	T	F	F	F	T	F
T	F	F	T	F	T	F
F	T	T	F	T	F	T
F	F	T	T	F	T	F

19. True **20.** True **21.** False **22.** False **23.** False

24. A **25.** D **26.** B **27.** B **28.** A
29. C **30.** D **31.** C **32.** A **33.** D
34. C **35.** C **36.** B **37.** D **38.** C
39. A **40.** B **41.** C **42.** B **43.** A
44. D **45.** C **46.** B