

Section 1.3 contains the bread and butter of symbolic logic, and thus very useful in math, in computer science, and if life. Key words here are: conditional proposition, converse, biconditional proposition, DeMorgan's Laws of Logic, negation of conditional propositions, contrapositive, and logical equivalence.

1. (Fill in the blanks.) Let p and q be propositions. Then the proposition of the form

$p \longrightarrow q$ is called a _____ proposition

where p is called the _____, q is called the _____, and its truth table is:

p	q	$p \longrightarrow q$
T	T	
T	F	
F	T	
F	F	

Explain in your own words why $p \longrightarrow q$ is true when $p = F$.

2. Let $p = F$, $q = T$, and $r = T$. Determine the truth values of the propositions below.

(a) $p \vee q \longrightarrow r$

(b) $p \longrightarrow \neg(q \wedge r) \vee p$

(c) $p \longrightarrow q$

3. Let p : *The bird is a raven.* and q : *The bird is black.* The following table lists sentences in English that are equivalent to $p \longrightarrow q$.

short-hand	example
if - then	If the bird is a raven, then the bird is black.
only if	The bird is a raven only if the bird is black.
when	When a bird is a raven, the bird is black.
necessary condition	A necessary condition for a bird to be a raven is that the bird be black.
sufficient condition	A sufficient condition for a bird to be black is that the bird is a raven.

Rewrite the sentences below in the form of an **If-then** sentence.

- (a) Today is Friday only if we have a quiz.

(b) When it is cold, my car won't start.

(c) A necessary condition to enroll at Hogwarts is that you are a witch or wizard.

(d) A sufficient condition to have experienced frequent earth quakes is to be a resident of Oklahoma.

4. (Fill in the blanks.) Let p and q be propositions. Then the proposition of the form

$p \longleftrightarrow q$ is called a _____ proposition.

with truth table:

p	q	$p \longleftrightarrow q$
T	T	
T	F	
F	T	
F	F	

Give an equivalent formulation of the biconditional proposition in terms of the conditional proposition.

5. State De Morgan's Laws for Logic.

6. Use De Morgan's Laws for Logic to write a sentence in English equivalent to $\neg(p \vee q)$ if p : *Hermione studies a lot.* and q : *Ron isn't serious.*

7. State the negation of $p \longrightarrow q$ symbolically (using $\wedge$) and explain how you know you are correct.

8. Write the negation of the statement: r : *If Donald Trump is elected President, David Brooks will eat his shoe.*

9. Write the *converse* of the proposition r above.

10. Write the *contrapositive* of the proposition r above.

11. How would you convince another student that a conditional proposition is equivalent to its contrapositive and not equivalent to its converse with appealing to a truth table.