

# LOGICAL CONNECTIVES

## Contradiction (false)

Notation	Formulas	Truth table	Venn diagram	Example												
$\perp$ "bottom"	$P \wedge \neg P$ $Opq$	<table> <tr> <td></td> <td><math>Q</math></td> <td></td> </tr> <tr> <td></td> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> </table>		$Q$			0	1	0	0	0	1	0	0		The moon is out and the moon is not out.
	$Q$															
	0	1														
0	0	0														
1	0	0														

## Tautology (true)

Notation	Formulas	Truth table	Venn diagram	Example									
$\top$ "top"	$P \vee \neg P$ $\vee pq$	<table> <tr> <td></td> <td>Q</td> <td></td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </table>		Q		0	1	1	1	1	1		The moon is out or the moon is not out,
	Q												
0	1	1											
1	1	1											


## Proposition P

Notation	Formulas	Truth table	Venn diagram	Example												
$P$	$P$ $Ipq$	<table> <tr> <td></td> <td>Q</td> <td></td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> </tr> </table>		Q		0	0	0	0	1	0	1	1	1		The moon is out.
	Q															
0	0	0														
0	1	0														
1	1	1														

## Negation of P

Notation	Formulas	Truth table	Venn diagram	Example									
$\neg P$ $\neg P$	$Np$ $Fpq$	<table> <tr> <td></td> <td>Q</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> </table>		Q	1	0	1	1	1	0	0		The moon is not out.
	Q	1											
0	1	1											
1	0	0											

## Proposition Q

Notation	Formulas	Truth table	Venn diagram	Example										
$Q$	$q$ $Hpq$	<table><tr><td></td><td><math>Q</math></td></tr><tr><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td></tr></table>		$Q$	0	0	0	1	1	0	1	1		I am awake.
	$Q$													
0	0													
0	1													
1	0													
1	1													

## Negation of Q

Notation	Formulas	Truth table	Venn diagram	Example								
$\neg Q$ $\sim Q$	$Nq$ $Gpq$	<table> <tr> <td></td> <td><math>Q</math></td> </tr> <tr> <td></td> <td><math>0 \quad 1</math></td> </tr> <tr> <td><math>P</math></td> <td><math>1 \quad 0</math></td> </tr> <tr> <td><math>1</math></td> <td><math>1 \quad 0</math></td> </tr> </table>		$Q$		$0 \quad 1$	$P$	$1 \quad 0$	$1$	$1 \quad 0$		I am not awake.
	$Q$											
	$0 \quad 1$											
$P$	$1 \quad 0$											
$1$	$1 \quad 0$											

## Conjunction

Notation	Formulas	Truth table	Venn diagram	Example										
$P \wedge Q$ $P \& Q$ $P \cdot Q$ $P_{\text{AND}} Q$	$P \wedge Q$ $P \& Q$ $\neg P \wedge \neg Q$ $Kpq$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	0	0	0	1	1	0	1	1		The moon is out and I am awake.
	Q													
0	0													
0	1													
1	0													
1	1													

## Alternative Denial

Notation	Formulas	Truth table	Venn diagram	Example										
$P \uparrow Q$ $P   Q$ $P_{\text{NAND}} Q$	$P \rightarrow \neg Q$ $\neg P \leftarrow Q$ $\neg P \vee \neg Q$ $Dpq$	<table><tr><td></td><td>Q</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>		Q	0	1	1	1	0	1	1	0		The moon is not out if I am awake.
	Q													
0	1													
1	1													
0	1													
1	0													

## Disjunction

Notation	Formulas	Truth table	Venn diagram	Example										
$P \vee Q$ $P \text{ OR } Q$	$P \leftarrow \neg Q$ $\neg P \rightarrow Q$ $\neg P \uparrow \neg Q$ $\neg(\neg P \wedge \neg Q)$ $A p q$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	0	0	0	1	1	0	1	1		The moon is out or I am awake.
	Q													
0	0													
0	1													
1	0													
1	1													

## Joint Denial

Notation	Formulas	Truth table	Venn diagram	Example												
$P \downarrow Q$ $P_{\text{NOR}} Q$	$P \nleftrightarrow Q$ $\neg P \wedge \neg Q$ $Xpq$	<table> <tr> <td></td> <td>Q</td> <td></td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> </tr> <tr> <td>P</td> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> </tr> </table>		Q		0	1	0	P	0	0	1	0	0		<p>The moon is not out nor am I awake.</p>
	Q															
0	1	0														
P	0	0														
1	0	0														

## Material Nonimplication

Notation	Formulas	Truth table	Venn diagram	Example												
$P \nrightarrow Q$ $P \not\supset Q$	$P \wedge \neg Q$ $\neg P \downarrow Q$ $\neg P \wedge \neg Q$ $\neg P \vee \neg Q$ $\neg(P \supset Q)$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>P</td> <td>0</td> </tr> <tr> <td></td> <td>0</td> </tr> <tr> <td></td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	P	0		0		1	1	0	1	1		Just because the moon is out does not mean I am awake.
	Q															
P	0															
	0															
	1															
1	0															
1	1															

## Material Implication

Notation	Formulas	Truth table	Venn diagram	Example										
$P \rightarrow Q$ $P \supset Q$	$P \rightarrow Q$ $\neg P \vee Q$ $\neg P \vee \neg Q$ $Cpq$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	0	1	0	1	1	0	1	1		If the moon is out then I am awake.
	Q													
0	1													
0	1													
1	0													
1	1													

## Converse Nonimplication

Notation	Formulas	Truth table	Venn diagram	Example										
$P \nleftarrow Q$ $P \not\leftarrow Q$	$P \downarrow \neg Q$ $\neg P \wedge Q$ $\neg P \wedge \neg Q$ $Mpq$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	0	0	0	1	1	0	1	1		The moon is not out but I am awake.
	Q													
0	0													
0	1													
1	0													
1	1													

## Converse Implication

Notation	Formulas	Truth table	Venn diagram	Example										
$P \leftarrow Q$ $P \subset Q$	$P \vee \neg Q$ $\neg P \uparrow Q$ $\neg P \rightarrow \neg Q$ $Bpq$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </table>		Q	0	1	0	0	1	1	1	0		<p>The moon is out if I am awake.</p>
	Q													
0	1													
0	0													
1	1													
1	0													

## Exclusive Disjunction

Notation	Formulas	Truth table	Venn diagram	Example												
$P \nleftrightarrow Q$ $P \neq Q$ $P \oplus Q$ $P_{\text{XOR}} Q$	$P \rightarrow \neg Q$ $\neg P \rightarrow Q$ $\neg P \leftrightarrow \neg Q$ $Jpq$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>P</td> <td>0</td> </tr> <tr> <td></td> <td>0</td> </tr> <tr> <td></td> <td>1</td> </tr> <tr> <td></td> <td>0</td> </tr> <tr> <td></td> <td>1</td> </tr> </table>		Q	P	0		0		1		0		1		<p>Either the moon is out or I am awake—never both.</p>
	Q															
P	0															
	0															
	1															
	0															
	1															

## Biconditional

Notation	Formulas	Truth table	Venn diagram	Example										
$P \leftrightarrow Q$ $P = Q$ $P_{\text{IFF}} Q$ $P_{\text{IFF}} Q$	$P \leftrightarrow Q$ $\neg P \leftrightarrow Q$ $\neg P \leftrightarrow \neg Q$ $E p q$	<table> <tr> <td></td> <td>Q</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> <tr> <td>1</td> <td>1</td> </tr> </table>		Q	0	1	0	1	1	0	1	1		<p>The moon is out if and only if I am awake</p>
	Q													
0	1													
0	1													
1	0													
1	1													