

Section 1.12: The Biconditional

Answers

Here are the truth tables for the expressions in questions 1 through 15.

p	q	\bar{p}	\bar{q}	$p \rightarrow q$	$\bar{p} \rightarrow \bar{q}$	$\bar{q} \rightarrow \bar{p}$	$q \rightarrow p$	$\bar{p} \vee q$	$p \wedge \bar{q}$
0	0	1	1	1	1	1	1	1	0
0	1	1	0	1	0	1	0	1	0
1	0	0	1	0	1	0	1	0	1
1	1	0	0	1	1	1	1	1	0

p	q	\bar{p}	\bar{q}	$p \leftrightarrow q$	$\bar{p} \leftrightarrow \bar{q}$	$p \oplus q$	$p \vee \bar{q}$	$\bar{p} \oplus \bar{q}$
0	0	1	1	1	1	0	1	0
0	1	1	0	0	0	1	0	1
1	0	0	1	0	0	1	1	1
1	1	0	0	1	1	0	1	0

p	q	$(p \rightarrow q) \wedge (q \rightarrow p)$	$(p \rightarrow q) \vee (q \rightarrow p)$	$(p \rightarrow q) \wedge (\bar{p} \rightarrow \bar{q})$	$(p \rightarrow q) \vee (\bar{p} \rightarrow \bar{q})$
0	0	1	1	1	1
0	1	0	1	0	1
1	0	0	1	0	1
1	1	1	1	1	1

16. By comparing columns, the following expressions are logically equivalent to $p \leftrightarrow q$:

- a) $\bar{p} \leftrightarrow \bar{q}$ (question #8)
- b) $(p \rightarrow q) \wedge (q \rightarrow p)$ (question #12)
- c) $(p \rightarrow q) \wedge (\bar{p} \rightarrow \bar{q})$ (question #14)

(and you may or may not have noticed that it's also equal to $\overline{p \oplus q}$, which is kind of cool)

17. By comparing columns, the following expressions are logically equivalent to $p \rightarrow q$:

- a) $\bar{q} \rightarrow \bar{p}$ (question #3)
- b) $\bar{p} \vee q$ (question #5)

18. By comparing columns, the following expressions are logically equivalent to $q \rightarrow p$:

a) $\bar{p} \rightarrow \bar{q}$ (question #2)

b) $p \vee \bar{q}$ (question #10)

19. False

20. False

21. True

22. False

23. False

24. True

25. True

26. False

27. $p \leftrightarrow q$

28. $\bar{q} \leftrightarrow \bar{p}$

29. $p \rightarrow q$

30. $\bar{q} \rightarrow \bar{p}$

31. Yes

32. Yes

33. a) No b) Yes c) No d) Yes

34. a) No b) No c) Yes d) Yes

35. a) Yes b) No c) Yes d) No

36. b) and d)