# Section 1.12: The Biconditional

**Exercises**

Write out the truth tables for the following logical expressions. (You might want to do it as just one or two really big tables.)

1. $p \rightarrow q$

2. $\overline{p} \rightarrow \overline{q}$

3. $\overline{q} \rightarrow \overline{p}$

4. $q \rightarrow p$

5. $\overline{p} \vee q$

6. $p \wedge \overline{q}$

7. $p \leftrightarrow q$

8. $\overline{p} \leftrightarrow \overline{q}$

9. $p \oplus q$

10. $p \vee \overline{q}$

11. $\overline{p} \oplus \overline{q}$

12. $(p \rightarrow q) \wedge (q \rightarrow p)$

13. $(p \rightarrow q) \vee (q \rightarrow p)$

14. $(p \rightarrow q) \wedge (\overline{p} \rightarrow \overline{q})$

15. $(p \rightarrow q) \vee (\overline{p} \rightarrow \overline{q})$

16. Looking at your results questions 1–15, which expressions are logically equivalent to $p \leftrightarrow q$?

17. Looking at your results for questions 1–15, which expressions are logically equivalent to $p \rightarrow q$?

18. Looking at your results for questions 1–15, which expressions are logically equivalent to q→p?

Consider the following conditional statements. I hope you agree that they all make a certain amount of sense. However, if they were rewritten as **biconditional** statements, would they continue to make sense? Answer True or False.

19. If Barney is a dog, then he has four legs.

20. If Rich is asleep, then he is not playing ping-pong.

21. If Alycia gets 90% or better as her final mark, she will get an A+.

22. If Bossy is mooing, then she is a cow.

23. If Pat sleeps in, she is late for class.

24. If Frank does not pay his bill on time, he will be charged a late charge.

25. If Susan bought her computer less than a year ago, her warranty is still in effect.

26. If Raymond eats a burger for dinner, he will be too full for dessert.


In the following exercises, let p denote "Pat eats a burger for dinner" and let q denote "Pat is too full for dessert." Translate the following sentences into logical symbols.

27. If and only if Pat eats a burger for dinner, she will be too full for dessert.

28. Pat will not be too full for dessert if and only if she did not eat a burger for dinner.

29. If Pat eats a burger for dinner, then she will be too full for dessert.

30. If Pat is not too full for dessert, then she did not eat a burger for dinner.


Are the following sentences biconditional statements? (In other words, could you replace them by an equivalent "if and only if" construction?)

31. If Frank does not pay his bill on time, then he will be charged a late charge, and if he does pay his bill on time, he will not be charged a late charge.

32. If Alycia gets 90% or better as her final mark, she will get an A+, and if she gets an A+, then she got 90% or better as her final mark.

33. The following conditional statement is true:  If and only if Pat is eaten by bears, she will not finish her marking.  Given that, answer the following questions.

    a)  Pat is eaten by bears.  Did she finish her marking?
    b)  Pat is not eaten by bears.  Did she finish her marking?
    c)  Pat finished her marking.  Was she eaten by bears?
    d)  Pat did not finish her marking.  Was she eaten by bears?

34. The following conditional statement is true:  If Rich is asleep, then he is not playing ping-pong and vice versa.  Given that, answer the following questions.

    a)  Rich is playing ping-pong.  Is he asleep?
    b)  Rich is asleep.  Is he playing ping-pong?
    c)  Rich is not asleep.  Is he playing ping-pong?
    d)  Rich is not playing ping-pong.  Is he asleep?

35. The following conditional statement is true:  Ettercaps are green if and only if toves are slithy.  Given that, answer the following questions.

    a)  Toves are slithy.  Are ettercaps green?
    b)  Toves are not slithy.  Are ettercaps green?
    c)  Ettercaps are green.  Are toves slithy?
    d)  Ettercaps are red.  Are toves slithy?

36. If the statement "If and only if Superman has a cape, then he can fly" is a true statement, which of the following cannot occur?  (You may choose more than one.)

    a)  Superman has a cape and he can fly.
    b)  Superman has a cape and he cannot fly.
    c)  Superman does not have a cape and cannot fly.
    d)  Superman does not have a cape and can fly.