

pp. 37, Exercise Set 2.1

8. b.  $\sim w \wedge (h \wedge s)$

c.  $\sim w \wedge \sim h \wedge \sim s$

e.  $w \wedge \sim (h \wedge s)$  ( $w \wedge (\sim h \vee \sim s)$  is also acceptable)

15.

$p$	$q$	$r$	$\sim q$	$\sim q \vee r$	$p \wedge (\sim q \vee r)$
$T$	$T$	$T$	$F$	$T$	$T$
$T$	$T$	$F$	$F$	$F$	$F$
$T$	$F$	$T$	$T$	$T$	$T$
$T$	$F$	$F$	$T$	$T$	$T$
$F$	$T$	$T$	$F$	$T$	$F$
$F$	$T$	$F$	$F$	$F$	$F$
$F$	$F$	$T$	$T$	$T$	$F$
$F$	$F$	$F$	$T$	$T$	$F$

20.

$p$	$c$	$p \wedge c$	$p \vee c$
$T$	$F$	$F$	$T$
$F$	$F$	$F$	$F$

←

different truth values in row 1

The truth table shows that  $p \wedge c$  and  $p \vee c$  do not always have the same truth values. Thus they are not logically equivalent.

31. The train is not late and my watch is not fast.

46. b. Yes.

$p$	$q$	$r$	$p \oplus q$	$q \oplus r$	$(p \oplus q) \oplus r$	$p \oplus (q \oplus r)$
$T$	$T$	$T$	$F$	$F$	$T$	$T$
$T$	$T$	$F$	$F$	$T$	$F$	$F$
$T$	$F$	$T$	$T$	$T$	$F$	$F$
$T$	$F$	$F$	$T$	$F$	$T$	$T$
$F$	$T$	$T$	$T$	$F$	$F$	$F$
$F$	$T$	$F$	$T$	$T$	$T$	$T$
$F$	$F$	$T$	$F$	$T$	$T$	$T$
$F$	$F$	$F$	$F$	$F$	$F$	$F$

same truth values

The truth table shows that  $(p \oplus q) \oplus r$  and  $p \oplus (q \oplus r)$  always have the same truth values. So they are logically equivalent.

c. Yes.

$p$	$q$	$r$	$p \oplus q$	$p \wedge r$	$q \wedge r$	$(p \oplus q) \wedge r$	$(p \wedge r) \oplus (q \wedge r)$
$T$	$T$	$T$	$F$	$T$	$T$	$F$	$F$
$T$	$T$	$F$	$F$	$F$	$F$	$F$	$F$
$T$	$F$	$T$	$T$	$T$	$F$	$T$	$T$
$T$	$F$	$F$	$T$	$F$	$F$	$F$	$F$
$F$	$T$	$T$	$T$	$F$	$T$	$T$	$T$
$F$	$T$	$F$	$T$	$F$	$F$	$F$	$F$
$F$	$F$	$T$	$F$	$F$	$F$	$F$	$F$
$F$	$F$	$F$	$F$	$F$	$F$	$F$	$F$

same truth values

The truth table shows that  $(p \oplus q) \wedge r$  and  $(p \wedge r) \oplus (q \wedge r)$  always have the same truth values. So they are logically equivalent.

### pp. 49, Exercise Set 2.2

10.

$p$	$q$	$r$	$p \rightarrow r$	$q \rightarrow r$	$(p \rightarrow r) \leftrightarrow (q \rightarrow r)$
$T$	$T$	$T$	$T$	$T$	$T$
$T$	$T$	$F$	$F$	$F$	$T$
$T$	$F$	$T$	$T$	$T$	$T$
$T$	$F$	$F$	$F$	$T$	$F$
$F$	$T$	$T$	$T$	$T$	$T$
$F$	$T$	$F$	$T$	$F$	$F$
$F$	$F$	$T$	$T$	$T$	$T$
$F$	$F$	$F$	$T$	$T$	$T$

14. a.

$p$	$q$	$r$	$\sim q$	$\sim r$	$q \vee r$	$p \wedge \sim q$	$p \wedge \sim r$	$p \rightarrow q \vee r$	$p \wedge \sim q \rightarrow r$	$p \wedge \sim r \rightarrow q$
$T$	$T$	$T$	$F$	$F$	$T$	$F$	$F$	$T$	$T$	$T$
$T$	$T$	$F$	$F$	$T$	$T$	$F$	$T$	$T$	$T$	$T$
$T$	$F$	$T$	$T$	$F$	$T$	$T$	$F$	$T$	$T$	$T$
$T$	$F$	$F$	$T$	$T$	$F$	$T$	$T$	$F$	$F$	$F$
$F$	$T$	$T$	$F$	$F$	$T$	$F$	$F$	$T$	$T$	$T$
$F$	$T$	$F$	$T$	$T$	$T$	$F$	$F$	$T$	$T$	$T$
$F$	$F$	$T$	$T$	$F$	$T$	$F$	$F$	$T$	$T$	$T$
$F$	$F$	$F$	$T$	$T$	$F$	$F$	$F$	$T$	$T$	$T$

same truth values

The truth table shows that the three statement forms  $p \rightarrow q \vee r$ ,  $p \wedge \sim q \rightarrow r$ , and  $p \wedge \sim r \rightarrow q$  always have the same truth values. Thus they are all logically equivalent.

b. If  $n$  is prime and  $n$  is not odd, then  $n$  is 2.

And: If  $n$  is prime and  $n$  is not 2, then  $n$  is odd.

45. If this computer program produces error messages during translation, then it is not correct.

If this computer program is correct, then it does not produce error messages during translation.

**Exercise Set 2.3, exercises 7,12,37(similar to Example 2.3.8)**

12. b.

$p$	$q$	premises		conclusion
$p$	$q$	$p \rightarrow q$	$\sim p$	$\sim q$
$T$	$T$	$T$	$F$	
$T$	$F$	$F$	$F$	
$F$	$T$	$T$	$T$	$F$ ← critical row
$F$	$F$	$T$	$T$	$T$ ← critical row

Rows 3, and 4 of the truth table represent the situations in which all the premises are true, but row 3 shows that it is possible for an argument of this form to have true premises and a false conclusion. Hence the argument form is invalid.