First, read the paragraph in the problem section of the textbook about the logical operators NAND and NOR and the problems relate to them, numbers 46–54. Then do the following problems.

(a) Use a truth table to verify each of the following.

- (i) $\neg p = p \downarrow p$
- (ii) $p \lor q = (p \downarrow q) \downarrow (p \downarrow q)$
- (iii) $p \land q = (p \downarrow p) \downarrow (q \downarrow q)$
- (b) Use the known relations between the standard five logical symbols and part (a) to write each of the following in terms of NOR (that is, \downarrow) alone.
 - (i) $p \to q$
 - (ii) $p \leftrightarrow q$
- (c) Write $\neg p$ in terms of *NAND* (that is, $| \rangle$) alone, and verify with a truth table.
- (d) Write $p \lor q$ in terms of *NAND* alone, and verify with a truth table.
- (e) Write $p \wedge q$ in terms of NAND alone, and verify with a truth table.
- (f) Use the known relations between the standard five logical symbols and parts (c), (d), and (e) to write each of the following in terms of *NAND* alone.
 - (i) $p \to q$
 - (ii) $p \leftrightarrow q$
- (g) Rewrite $p \land (q \to \neg r)$ in terms of just
 - (i) NOR
 - (ii) NAND