Exercises for 2.1–2.3

1. Which of the following are wff?

   (a) P
   (b) $W \vee S$
   (c) $\{[Y \wedge (\wedge T)] \wedge L\} \wedge L$
   (d) $(P \wedge M) \vee \neg[(W \wedge) \vee (R \vee Q)]$
   (e) $Z \vee Z$
   (f) $Z \wedge [(S \vee R) \wedge P \vee L]$
   (g) $Z \wedge [(S \vee R) \wedge (P \vee L)]$
   (h) $[(Z \vee L) \wedge \neg Z] \vee (Q \wedge S)$
   (i) $L \vee Q$
   (j) $L \vee Q \vee R$
   (k) WR
   (l) $S \vee (S \wedge Y)$
   (m) $(L \wedge T) \wedge \{[T \vee (\{\vee W)] \vee (Q \vee M)\}$
   (n) $[(L \wedge M) \vee P] \wedge (Y \vee P$
   (o) $[(L \wedge P) \vee T] \vee\vee (M \vee L)$
   (p) $L \wedge \{(W \wedge W) \wedge [(W \wedge Z) \vee (Z \vee P]\}$

2. Circle, highlight, or otherwise clearly mark the main connective of each of the following sentences.

   (a) $\{[(Z \wedge R) \wedge T] \wedge [(Y \wedge Y) \vee (S \wedge Z)]\} \vee [S \vee (T \vee Y)]$
   (b) $T \vee \neg W$
   (c) $\{[(W \wedge R) \wedge (L \wedge T)] \vee (P \wedge Z)\} \vee (Y \vee S)$
   (d) $[(Q \wedge Q) \wedge (R \vee Q)] \wedge [(L \wedge W) \vee T]$
   (e) $\neg R \vee \{(T \vee S) \wedge [\neg W \wedge (W \vee P)]\}$
   (f) $\neg M \wedge M$
   (g) $\neg(M \wedge M)$
   (h) $(L \wedge M) \vee \{[(T \vee S) \vee (Z \wedge T)] \wedge (W \wedge Y)\}$

(i) $M \wedge (Q \wedge Z)$

(j) $Q \vee S$

(k) $\{[(Q \vee P) \wedge (Y \wedge Y)] \vee [(M \vee S) \wedge T]\} \vee Q$

(l) $\neg Q$

(m) $\Big(\{[T \wedge (R \vee \neg Z)] \wedge Y\} \wedge (Z \wedge \neg T)\Big) \wedge (S \vee L)$

(n) $\neg P \wedge \{[(L \vee Y) \wedge (Z \wedge Q)] \vee [P \vee (M \wedge M)]\}$

(o) $(Q \wedge W) \vee (T \wedge P)$

(p) $(Q \wedge Q) \vee W$

(q) $[S \vee (W \wedge Y)] \wedge \{[Y \vee (Z \wedge Q)] \wedge Q\}$

(r) $\{(R \vee L) \wedge [(R \vee P) \wedge Y]\} \vee (Z \wedge Y)$

(s) $[(Z \vee M) \vee (S \wedge R)] \wedge \{[(S \wedge W) \wedge (L \vee Q)] \wedge Q\}$

3. Which of the sentences (a) through (h) in the previous question are of the form

   (a) $s_1 \vee s_2$

   (b) $s_2 \wedge s_2$

   (c) $\neg s$

4. A well-formed formula (wff) is a string of symbols (logical connectives, opening and closing brackets, letters of the Roman alphabet possibly with some subscripts). Let's think a bit about how a wff must look like. For each of the following claim, state whether it's true or false of wffs:

   (a) A closing bracket cannot be the first symbol.

   (b) A closing bracket cannot be the last symbol.

   (c) A logical connective cannot be the first symbol.

   (d) The negation can be the first symbol.

   (e) $\neg$ cannot be followed immediately by $\wedge$.

   (f) $\wedge$ cannot be followed immediately by $\neg$.

5. Take the truth table for conjunction. Plug $(A \wedge B)$ into s_1 and $(A \vee B)$ into s_2 and produce the resulting truth conditions for $(A \wedge B) \wedge (A \vee B)$.