Homework 1 Solutions

1. Pretty much everyone got this one right. Note that there I prefer to have one line per rule use (many people drew a line to each non-terminal and terminal, but this is just a style issue.

```
<e>
  - <e>; <e>
    + <e>; <e> <n>
      <n> <n> <d> <n><d> <d> 6 <d> 5 5 <d> 4
```

2. Note that in prefix the first operator given is the last one to be used, thus the unary minus gets used last – negating the entire expression.

   (a) \(3 \cdot 4 + c \cdot d / +\)

   (b) \(007 \text{ Audrey } 2 / + -\)
3. The grammar is ambiguous since it accepts the following two parse trees for the sentence "- 45"

4. Note that there is no way to get the correct meaning of EBNF braces without using recursion.

\[
\begin{align*}
\langle \text{Guard} \rangle & ::= \langle \text{Opnot} \rangle \langle \text{Pred} \rangle \mid \langle \text{Guard} \rangle \langle \text{Logop} \rangle \langle \text{Pred} \rangle \\
\langle \text{Pred} \rangle & ::= \langle \text{Expr} \rangle \langle \text{Mop} \rangle \langle \text{Expr} \rangle \\
\langle \text{Expr} \rangle & ::= \text{Num} \mid \text{id} \\
\langle \text{Opnot} \rangle & ::= \sim \mid \epsilon \\
\langle \text{Logop} \rangle & ::= \land \mid \lor \\
\langle \text{Mop} \rangle & ::= < \mid <\!\!\!\!\!\!\!\!\!= \mid > \mid >=
\end{align*}
\]

5.

\[\text{ifstmt} ::= \text{if Guard} \rightarrow \text{Slist} \{ [ ] \text{Guard} \rightarrow \text{Slist} \} \text{fi}\]

6. Make sure you understand why this grammar creates the proper precedence and associativity. How would I add another operator? How could I change the grammar to make subtraction right-associative?

\[
\begin{align*}
\langle \text{Asgn} \rangle & ::= \langle \text{lhs} \rangle ::= \langle \text{Expr} \rangle \mid \langle \text{lhs} \rangle , \langle \text{Asgn} \rangle , \langle \text{Expr} \rangle \\
\langle \text{Expr} \rangle & ::= \langle \text{Factor} \rangle \mid \langle \text{Expr} \rangle + \langle \text{Factor} \rangle \mid \langle \text{Expr} \rangle - \langle \text{Factor} \rangle \\
\langle \text{Factor} \rangle & ::= \langle \text{Term} \rangle \mid \langle \text{Factor} \rangle \ast \langle \text{Term} \rangle \mid \langle \text{Factor} \rangle / \langle \text{Term} \rangle \\
\langle \text{Term} \rangle & ::= (\langle \text{Expr} \rangle) \mid \text{Num} \mid \text{id} \\
\langle \text{lhs} \rangle & ::= \text{id}
\end{align*}
\]