1a. (10 pts) MINIMUM-REMAINING-VALUES HEURISTIC. Consider the assignment below. WA is already assigned, and some values in the domains of other variables have been eliminated. List all unassigned variables that might be selected by the Minimum-Remaining-Values (MRV) Heuristic: __________NT, SA________.

<table>
<thead>
<tr>
<th>WA</th>
<th>NT</th>
<th>Q</th>
<th>NSW</th>
<th>V</th>
<th>SA</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>G B</td>
<td>R G B</td>
<td>R G B</td>
<td>R G B</td>
<td>G B</td>
<td>R G B</td>
</tr>
</tbody>
</table>

1b. (10 pts) DEGREE HEURISTIC. Consider the assignment below. WA is already assigned, and some values in the domains of other variables have been eliminated. List all unassigned variables that might be selected by the Degree Heuristic: __________SA________.

<table>
<thead>
<tr>
<th>WA</th>
<th>NT</th>
<th>Q</th>
<th>NSW</th>
<th>V</th>
<th>SA</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>G B</td>
<td>R G B</td>
<td>R G B</td>
<td>R G B</td>
<td>G B</td>
<td>R G B</td>
</tr>
</tbody>
</table>

2. (5 pts each, 35 pts total) Mark the following reasoning patterns as S (= sound, carries true premises to true conclusions) or U (= unsound, may carry true premises to false conclusions). Premises are shown above the line, conclusions below the line. Here, “→” means “implies,” “¬” means “not,” and the solid horizontal line means “therefore.” The first one is done for you as an example.

2a. __S____.  
   P → Q  
   P  
   Q  

2b. __S____  
   P → Q  
   ¬ Q  
   ¬ P  

**** TURN PAGE OVER. QUIZ CONTINUES ON THE REVERSE ****
2c. \( \text{U} \) \( P \rightarrow Q \)  
2d. \( \text{U} \) \( \neg P \rightarrow Q \)  
2e. \( \text{S} \) \( P \rightarrow \neg Q \)  
2f. \( \text{S} \) \( P \rightarrow Q \) \( \neg P \) or \( Q \)  
2g. \( \text{U} \) \( P \rightarrow Q \)  
2h. \( \text{U} \) 50% of voters are Republican  
\( \text{P or } \neg Q \)  
50% of Republicans are women  
25% of voters are women

4. (20 pts total, 10 pts each) The following sentences are in Implicative Normal Form. Convert them to Conjunctive Normal Form (i.e., write each as the conjunction of one or more clauses, each clause of which is the disjunction of a set of literals).

4a. \( Q \Rightarrow S \). \( \neg Q \lor S \)  

4b. \( P \Leftrightarrow Q \). \( (P \lor \neg Q) \land (\neg P \lor Q) \). This is equivalent to \( (P \land Q) \lor (\neg P \land \neg Q) \)

5. (5 pts each, 25 pts total) In each of the following, \( \text{KB} \) is a set of sentences, \( \{\} \) is the empty set of sentences, and \( S \) is a single sentence. Recall that \( \models \) is read “entails” and that \( \vdash \) is read “derives.”

\( \text{S} = \text{Sound}. \) \( \text{U} = \text{Unsound}. \)  
\( \text{C} = \text{Complete}. \) \( \text{I} = \text{Incomplete}. \)  
\( \text{Sat} = \text{Satisfiable}. \) \( \text{Unsat} = \text{Unsatisfiable}. \)  
\( \text{V} = \text{Valid}. \) \( \text{N} = \text{None of the above}. \)

For each blank below, write in the key above that corresponds to the best term. The first one is done for you as an example.

5a. Let \( S \) be given in advance. Suppose that \( \{\} \models S \). Then \( S \) is \( \text{V} \).

5b. Let \( S \) be given in advance. Suppose that for some \( \text{KB1}, \) \( \text{KB1} \models S \); but that for some other \( \text{KB2}, \) \( \text{KB2} \models \neg S \). Then \( S \) is \( \text{Sat} \).

5c. Suppose that for any \( \text{KB} \) and any \( S \), whenever \( \text{KB} \models S \) then \( \text{KB} \vdash S \). Then the inference procedure is \( \text{C} \).

5d. Suppose that for some \( \text{KB} \) and some \( S \), \( \text{KB} \vdash S \) but not \( \text{KB} \models S \). Then the inference procedure is \( \text{U} \).

5e. Suppose that for some \( \text{KB} \) and some \( S \), \( \text{KB} \models S \) but not \( \text{KB} \vdash S \). Then the inference procedure is \( \text{I} \).

5f. Suppose that for any \( \text{KB} \) and any \( S \), whenever \( \text{KB} \vdash S \) then \( \text{KB} \models S \). Then the inference procedure is \( \text{S} \).