1. (3 pts) Consider a stack of six pancakes sizes 1, 2, 3, 4, 5, and 6 and the pancake problem discussed in class. Give a stack of these pancakes that require six flips to put them in sorted order (with 1 on the top). Show the sequence of pancakes after each flip and indicate where the spatula is inserted with a line. Explain why six flips are needed to sort the stack you have.

2. (1 pt) The pancake number \( P_6 = 7 \). Explain what that means.

3. (4 pts) Let \( p, q, \) and \( r \) be the following propositions.
   \[ p: \text{You have the flu.} \]
   \[ q: \text{You miss the final exam.} \]
   \[ r: \text{You pass the course.} \]

   Express each of the following propositions as English sentences.
   
   (a) \( q \rightarrow \neg r \)
   
   (b) \( (p \land q) \lor (\neg q \lor r) \)

4. (4 pts) Determine if these conditional statements are true or false.
   
   (a) if 5+1 = 7 then Durham is the capital of NC.
   
   (b) if Durham is not the capital of NC then 5+1 = 7

5. (3 pts) Show that \( (p \rightarrow r) \lor (q \rightarrow r) \) is logically equivalent to \( (p \land q) \rightarrow r \) with a truth table.

6. (3 pts) There is an island of knights and knaves. The knights always tell the truth. The knaves always lie. You encounter two people, A and B, and they both make a statement. Determine if you can tell what type of people each is or not and reason why.
   
   A says ”I am a knight”, B says ”I am a knight”

7. (3 pts) Same problem setup as 6) but now there is also a third type of person, a spy who can either lie or tell the truth.

   You encounter three people A, B, and C. You know one is a knight, one is a knave and one is a spy. Each of the three people knows the type of person each of the other two people is. Determine if there is a unique solution of who the knight, knave or spy is. If not list at least two possibilities.

   A says ”I am the knight.”, B says ”A is not the knave”, C says ”B is not the knave”.
8. (3 pts) Determine if the following is satisfiable.
\[(p \lor q \lor \neg r) \land (p \lor \neg q \lor \neg s) \land (p \lor \neg r \lor \neg s) \land (\neg p \lor \neg q \lor \neg s) \land (p \lor q \lor \neg s)\]

9. (3 pts) Show that \((p \rightarrow r) \lor (q \rightarrow r)\) is logically equivalent to \((p \land q) \rightarrow r\) by developing a series of logical equivalences.

10. (3 pts) Show that \(((p \lor q) \land (p \rightarrow r) \land (q \rightarrow r)) \rightarrow r\) is a tautology by developing a series of logical equivalences.