Activity: Logic Gates and Truth Tables

A. Why?

Basic logic gates are devices that perform simple functions on logical values. We can describe these functions using logical formulas or truth tables.

B. Outcomes

By the end of the activity you should

- Have practiced how to read and write logical "propositional" formulas with NOT, AND, OR, XOR, NAND, and NOR.
- Have some practice building a truth table for a logical formula.
- Compared some logical formulas (including DeMorgan's laws) for logical equivalence.

C. Questions

1. Assume the precedences of the logical operations are (in decreasing strength) NOT, AND/NAND (a tie), OR/NOR/XOR (another tie), IMPL, and IFF. Assume all the binary operators are right-associative. question: What do you get if you remove all the redundant parentheses in (NOT (P AND (NOT Q))) OR (NOT (R NAND S)) ?
2. What do you get if you add all the redundant parentheses to the formula NOT P AND Q AND NOT R IFF S XOR T IMPL U ?
3. Below are truth tables for AND, NAND, OR, NOR, XOR.

P	Q	P AND Q	P NAND Q	P OR Q	P NOR Q	P IMPL Q	P XOR Q	P IFF Q
0	0	0	1	0	1	1	0	1
0	1	0	1	1	0	1	1	0
1	0	0	1	1	0	0	1	0
1	1	1	0	1	0	1	0	1

Fill in the table below:

P	Q	NOT P	NOT Q	P NAND Q	NOT P NOR NOT Q	P NOR Q	NOT P NAND NOT Q
0	0						
0	1						
1	0						
1	1						

4. Two formulas are *logically equivalent* if their truth tables match exactly, row-by-row. Which pairs of formulas from Problem 4 are logically equivalent? (The equivalences are *DeMorgan's laws.*)