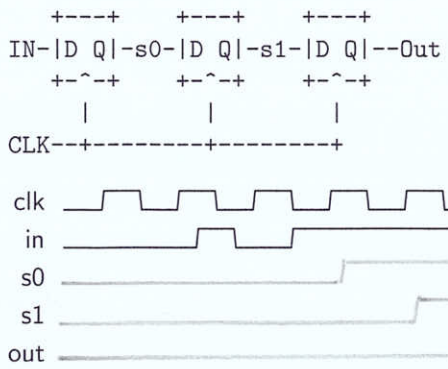
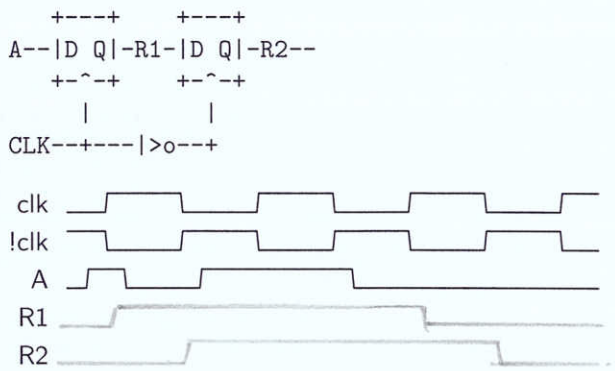
State

1. Fill out the timing diagram for the circuit below:

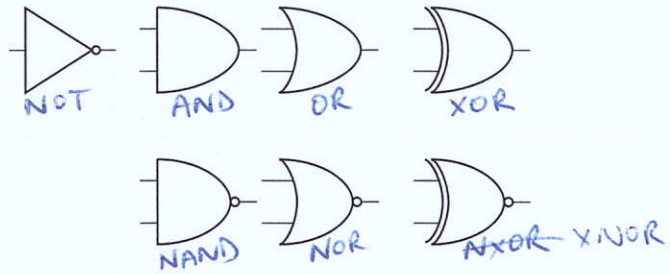


2. Fill out the timing diagram for the circuit below:



Logic Gates

1. Label the following logic gates:



2. Convert the following to boolean expressions:
   (a) NAND $Q = \overline{AB}$
   (b) XOR $Q = \bar{A}B + A\bar{B}$
   (c) XNOR $Q = AB + \bar{A}\bar{B}$

3. Create an AND gate using only NAND gates.

4. How many different two-input logic gates can there be? How many n-input logic gates?

16. There are 2^n lines in an n-input truth table. If ~~the numb~~ x = number of li
there are 2^x possible outputs. Since $x = 2^n$, there are 2^{2^n} n-input logic gates.

Boolean Logic

$1 + A = 1$	$A + \bar{A} = 1$	$A + AB = A$	$(A+B)(A+C) = A + BC$
$0B = 0$	$B\bar{B} = 0$	$A + \bar{A}B = A + B$	
DeMorgan's Law:	$\overline{AB} = \bar{A} + \bar{B}$	$\overline{A+B} = \bar{A}\bar{B}$	

1. Minimize the following boolean expressions:

(a) Standard: $(A+B)(A+\bar{B})C$

$= (A + B\bar{B})C = (A+0)C = AC$

(b) Grouping & Extra Terms: $\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + AB\bar{C} + A\bar{B}\bar{C} + ABC + A\bar{B}C$

$= (\bar{A}+A)\bar{B}\bar{C} + AB(\bar{C}+C) + \bar{A}B\bar{C} + A\bar{B}C = \bar{B}\bar{C} + AB + \bar{A}B\bar{C} + A\bar{B}C$

$= \bar{B}(\bar{C} + A\bar{C}) + B(A + \bar{A}\bar{C})$

$= \bar{B}(\bar{C} + A) + B(A + \bar{C}) = (\bar{B}+B)(A+\bar{C})$

$= A + \bar{C}$

(c) DeMorgan's: $\overline{A(\bar{B}\bar{C} + BC)}$

$= \bar{A} + \overline{(\bar{B}\bar{C} + BC)}$ → $\bar{A} + \bar{\bar{B}\bar{C}}\,\bar{BC}$ → $\bar{A} + (B+C)(\bar{B}+\bar{C})$

$= \bar{A} + \overline{\bar{B}\bar{C}}\,\overline{BC}$ ← wrong!

$= (\bar{A} + \bar{\bar{B}\bar{C}})(\bar{A} + \bar{BC})$ $= \bar{A} + B\bar{C} + C\bar{B} + C\bar{C}$

$= \bar{A} + \bar{0} = \bar{A} + 1$ $= (\bar{A} + B + C)(\bar{A} + \bar{B} + \bar{C})$ $= \bar{A} + B\bar{C} + \bar{B}C$

$= \bar{A}$