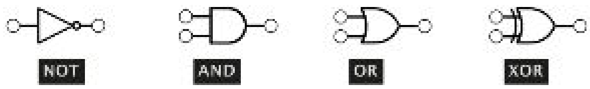
Cherry Rose Semena
Mahnaz Karimi
Diana Strele

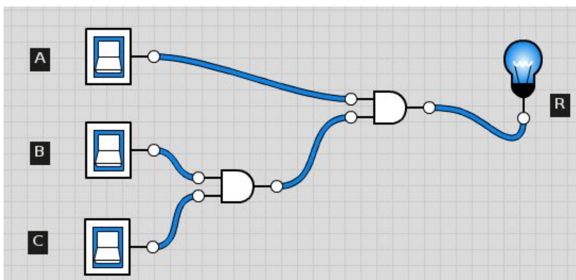
Assignment #1: LOGIC

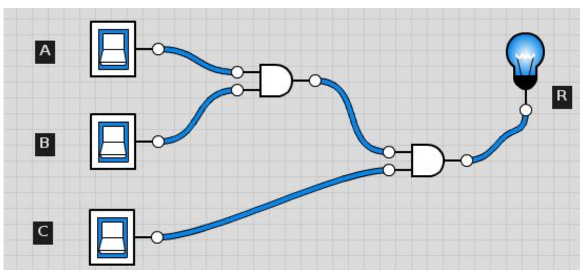
1. **Equivalence Laws**
   In digital electronics the following gates implements logical statements:



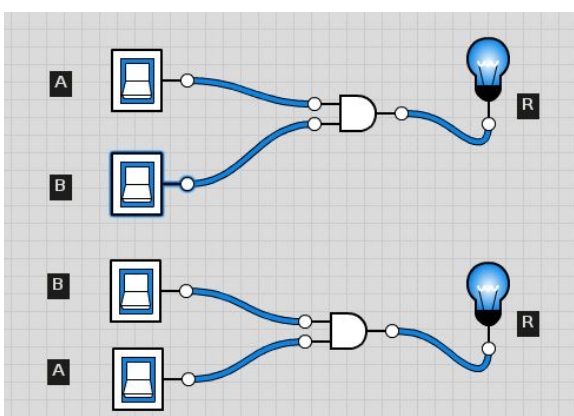
Write a diagram for each of the laws equivalence:

- **Associative** $a \wedge (b \wedge c) \equiv (a \wedge b) \wedge c$





- **Commutative** $a \wedge b \equiv b \wedge a$



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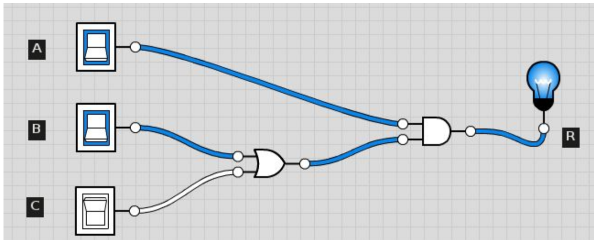
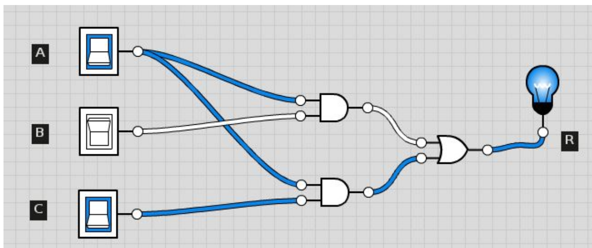
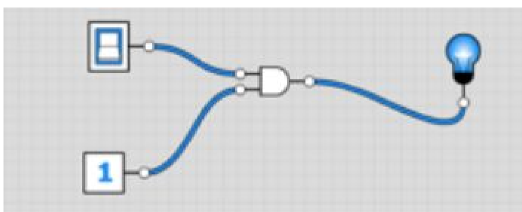
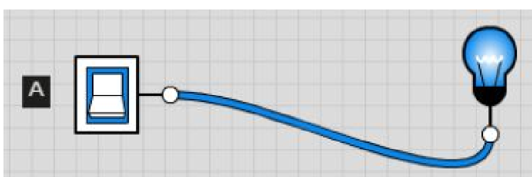
- **Distributive** *a ^ (b v c) ≡ (a ^ b) v (a ^ c)*





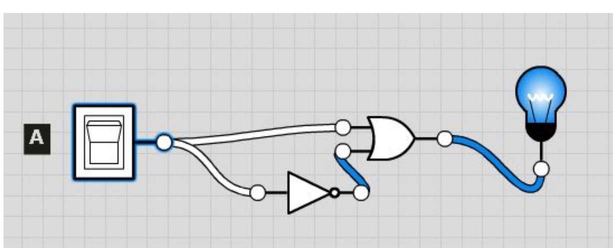
- **Identity** *a ^ t ≡ a*





Tautology is always TRUE in all cases.

- **Negation** *a v ¬a ≡ t*



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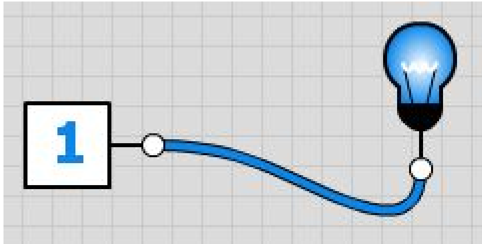
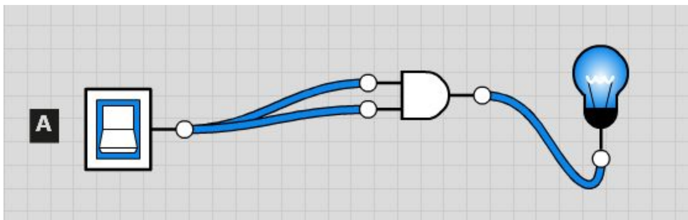
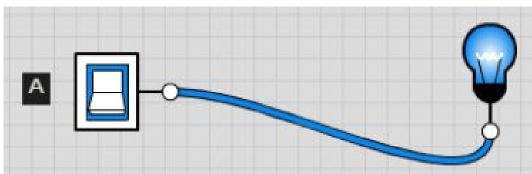
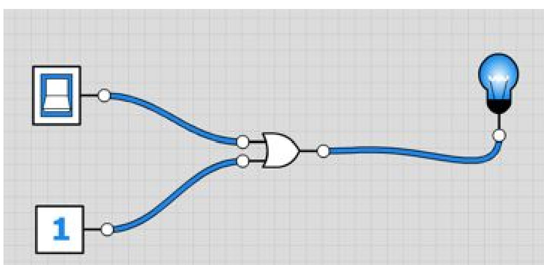


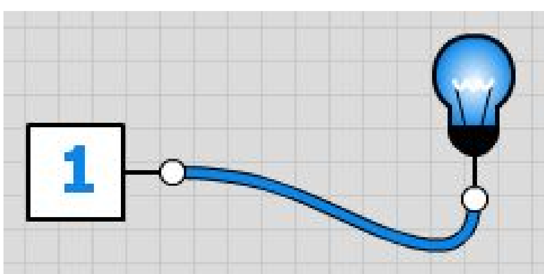
- **Idempotent** $a \wedge a \equiv a$



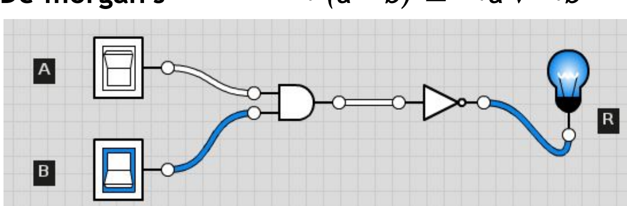


- **Universal bounds** $a \vee t \equiv t$





- **De morgan's** $\neg (a \wedge b) \equiv \neg a \vee \neg b$



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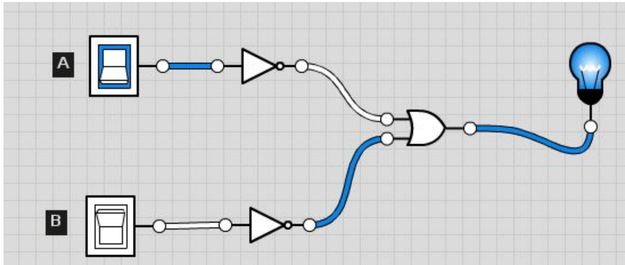
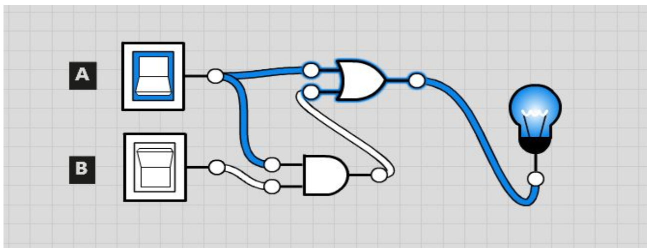
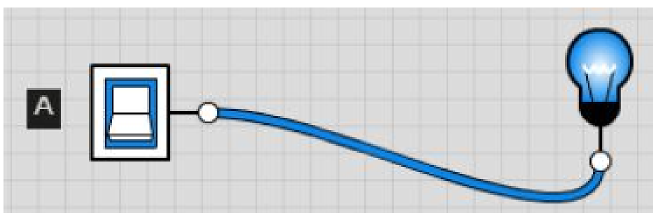


- **Absorption** *a v (a ^ b) ≡ a*





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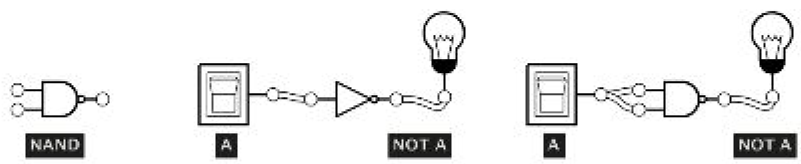
2. NAND

The simplest logic circuit to create is a nand gate. It has the following truth table and is equivalent to $\neg(a \wedge b)$:

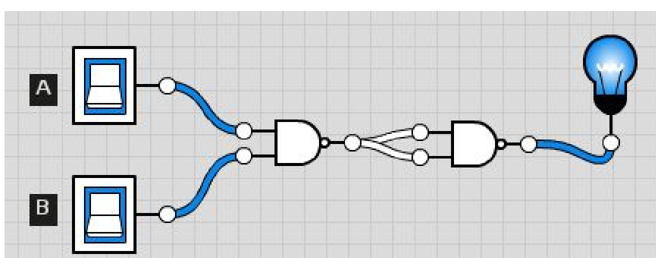
a	b	$\neg(a \wedge b)$
f	f	t
f	t	t
t	f	t
t	t	f

Nand has the special property, that any other binary operator can be built from NAND, here the NAND gate is shown and the implementation of **not**:

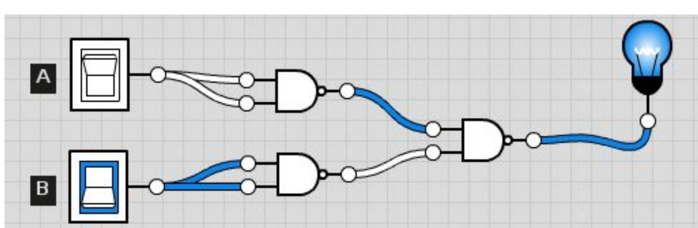


Build the operators **and**, **or**, and **implies** with NAND gates alone.

- And



- Or



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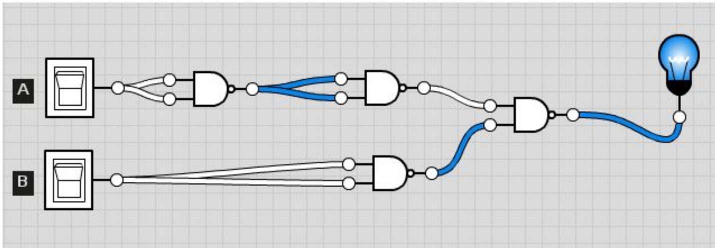
- Implies



a → b ≡ ¬a ∨ b, a conditional statement for implication. The diagram shows a → b which is equivalent to ¬a ∨ b, it would only be false if a is true and b is false then the rest of the cases are true.