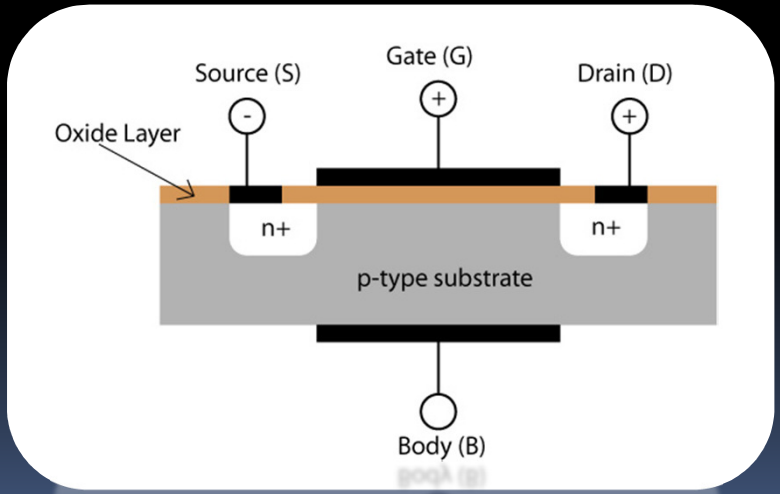
Quiz 2

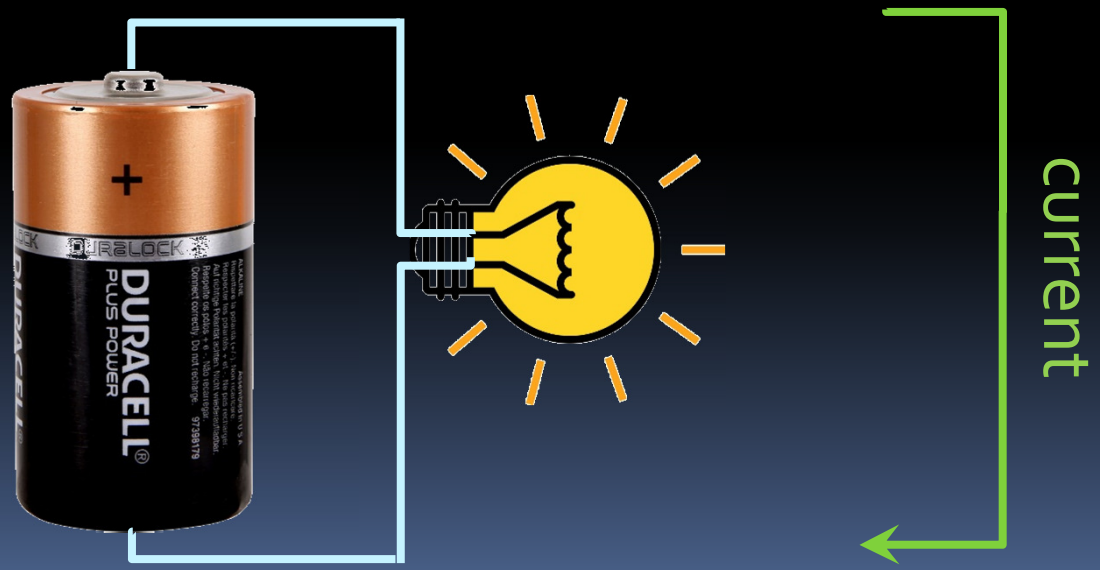
Week 1 Review

- Properties of electricity
- Semiconductor materials
  - Doping (n-type and p-type)
- p-n junctions
- Transistors
  - MOSFETs



Electricity review

- If electrons are traveling from the bottom of the battery to the top, which way is current said to be traveling?
  - Current is measured as the movement of positive charges.



Transistor review

- Logic gates are built from transistors

This transistor is called nMOS

It conducts (i.e., acts as a closed switch) if we apply 5 Volts (logic-1) at its gate.

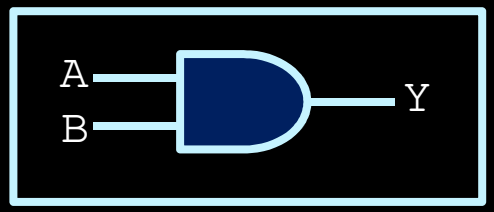
This transistor is called pMOS

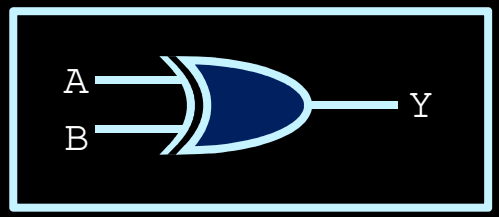
It conducts (i.e., acts as a closed switch, if we apply 0 Volts (logic-0 , Gnd) at its gate.

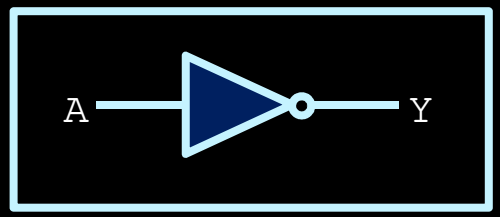
Basic Logic Gates: Symbols and Truth Tables

- What are the names and truth table values for the following gates?

How many transistors do you need to build a NOT gate?







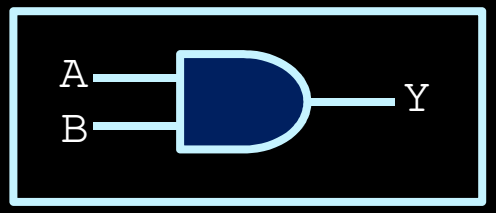
A	B	Y
0	0	
0	1	
1	0	
1	1	

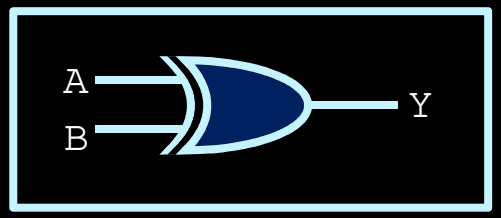
A	B	Y
0	0	
0	1	
1	0	
1	1	

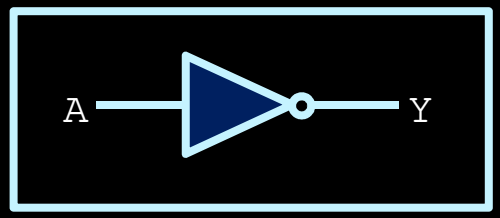
A	Y
0	
1	

Basic Logic Gates: Symbols and Truth Tables

- What are the names and truth table values for the following gates?





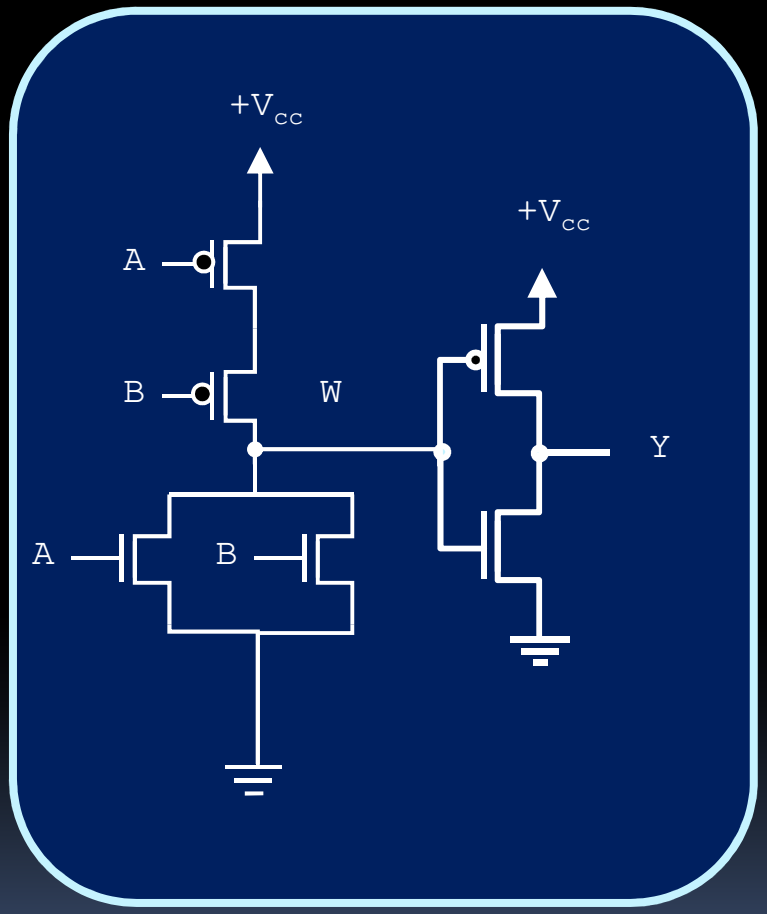


A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

A	Y
0	1
1	0

Question 1: Which gate is this one?

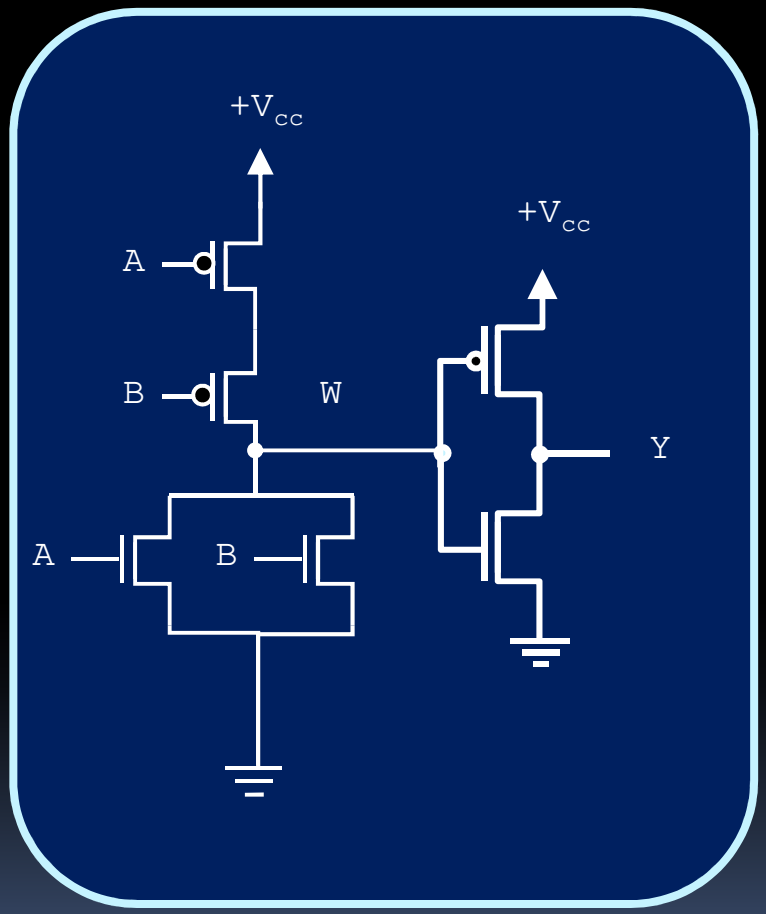


A	B	W	Y
0	0		
0	1		
1	0		
1	1		

W =

Y =

Which gate is this one?



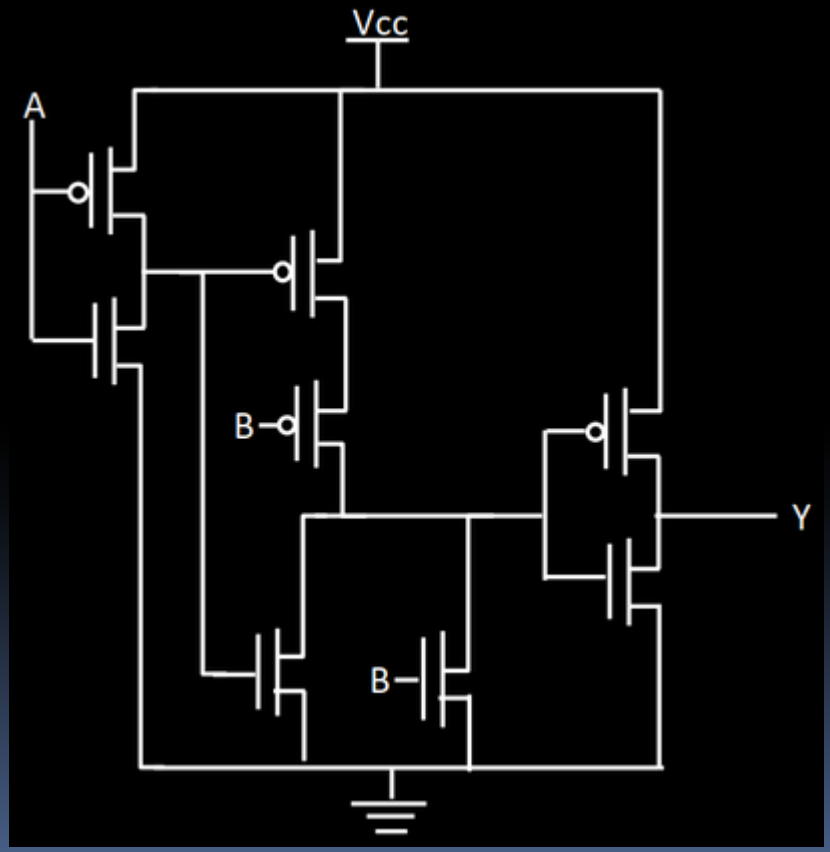
A	B	W	Y
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

$$W = \overline{(A + B)}$$

$$Y = (A + B)$$

Question 2

State the following output Y's Boolean expression in terms of A and B:



A	B	Y
0	0	1
0	1	1
1	0	0
1	1	1

Ans: $Y = A' + B$

Question 4

True or False? Doping gives a semiconductor an overall positive or negative charge.

Ans: False

Question 5

What kind of bias on a pn junction causes the depletion layer to expand?

Ans: Reverse Bias

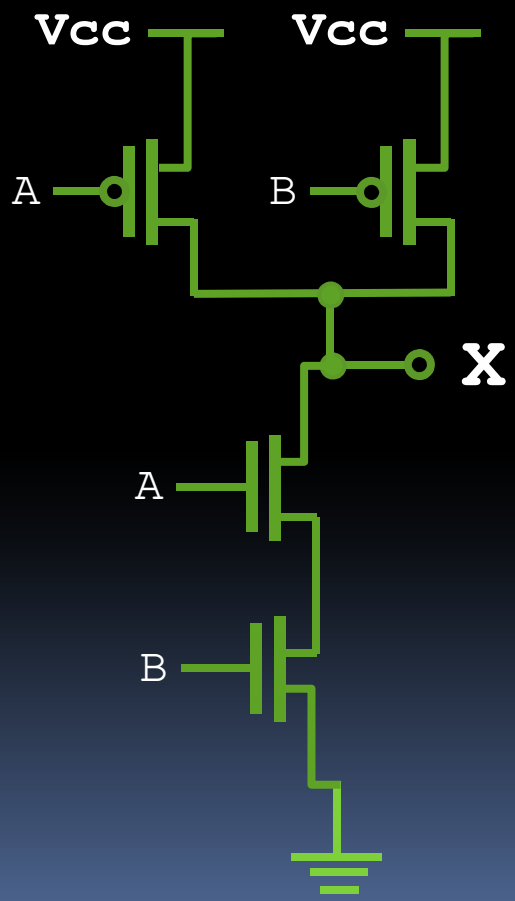
Question 6

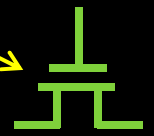
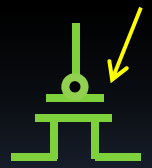
Phosphorus has 5 electrons in its outer valence shell. When added in small amounts to silicon, the result is a _____ semiconductor.

Ans: N-type

Question 7

- What gate is created by the following?

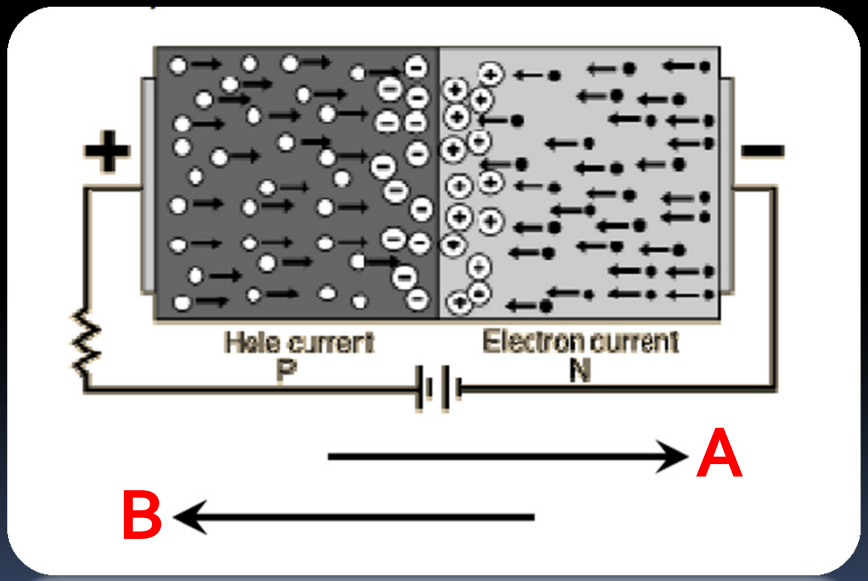


Remember: transistors that look like  are activated when the gate input is high, whereas transistors that look like  are activated when the gate input is low.

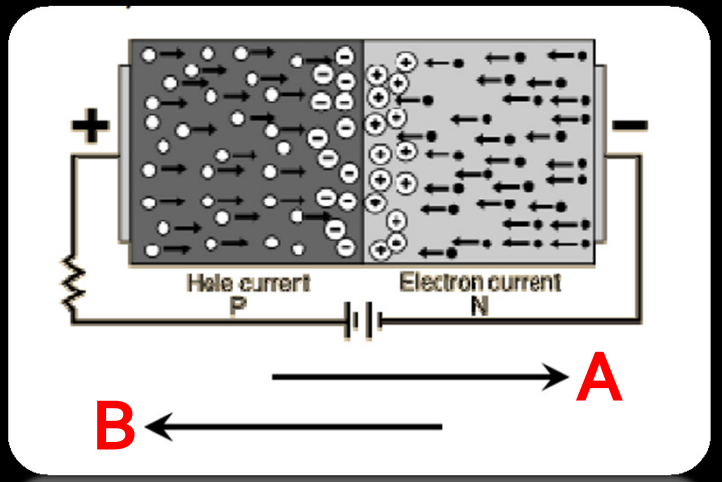
Ans: X = A NAND B

Question 8

- What is the name of currents A and B, and how are they produced?



Kinds of current



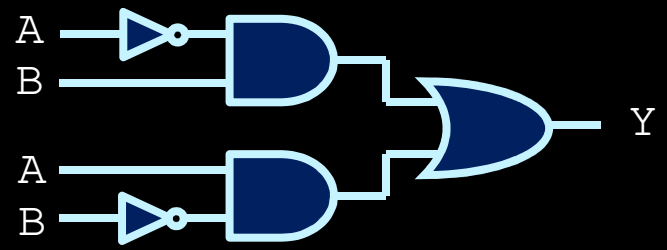
- Two things to note here:
  - Need to determine which electrons are moving from high concentration to low concentration (diffusion), and which are moving because of the electric field (drift).
  - Remember: Current is measured in the opposite direction of electron flow (i.e. as *the flow of positive charge* through the material)
  - A → diffusion B → drift

Group Questions & Answers

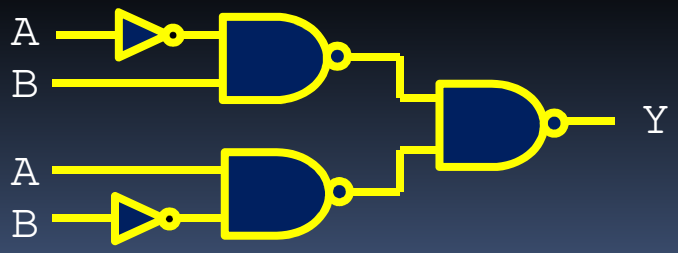
Question 1

- How can you express a two-input XOR gate as a combination of NAND and NOT gates?
  - Draw the circuit using only these two logic gates.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0



- Remember De Morgan's!
  - $(\overline{W} + \overline{Z}) = (\overline{W\,Z})$



Question 2

- What is the most reduced form, in sum of products form, of the function from the truth table on the right?

$$Y = m_0 + m_1 + m_2 + m_5 + m_7 + m_8 + m_9 + m_{10} + m_{13} + m_{15}$$

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

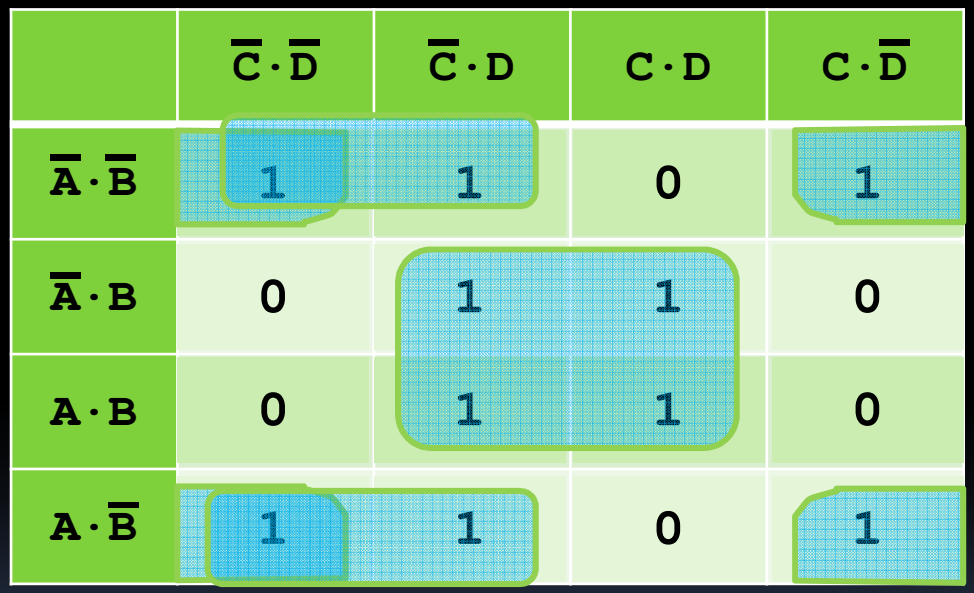
Question 2 (cont'd)

	$\overline{C}\cdot\overline{D}$	$\overline{C}\cdot D$	$C\cdot D$	$C\cdot\overline{D}$
$\overline{A}\cdot\overline{B}$	1	1	0	1
$\overline{A}\cdot B$	0	1	1	0
$A\cdot B$	0	1	1	0
$A\cdot\overline{B}$	1	1	0	1

$$Y = \overline{C}\cdot D + B\cdot D + \overline{B}\cdot\overline{D}$$

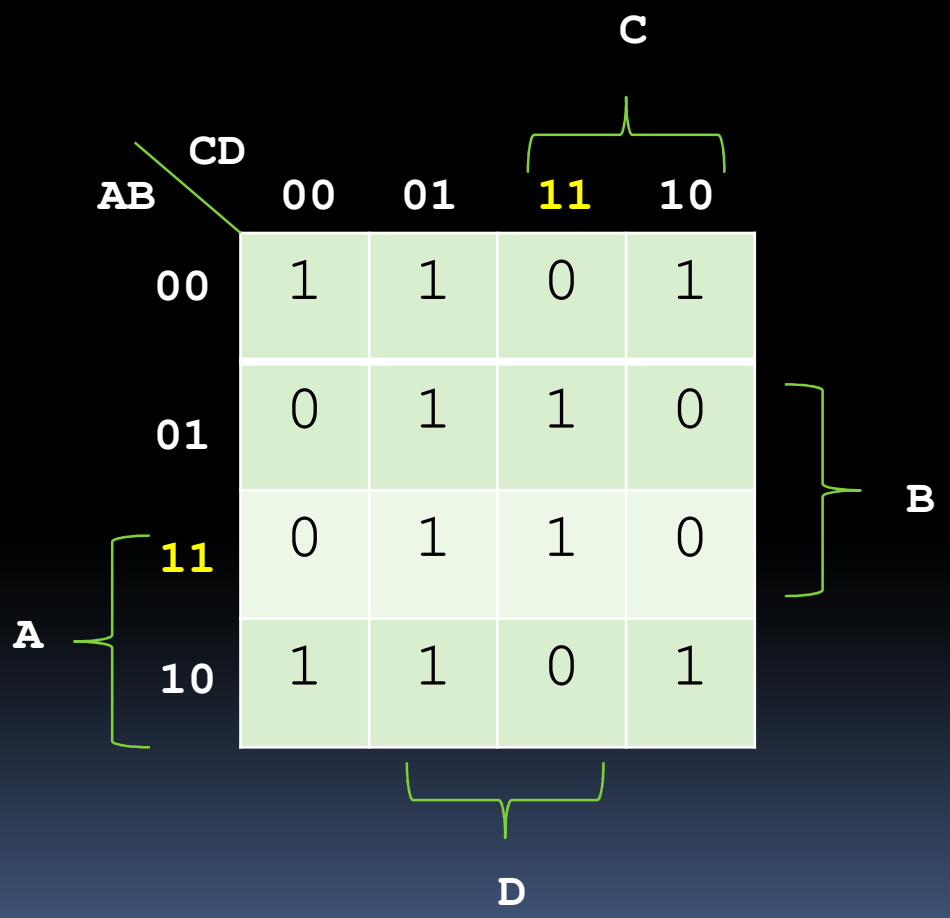
Question 2 (alternative)

- An alternative grouping:

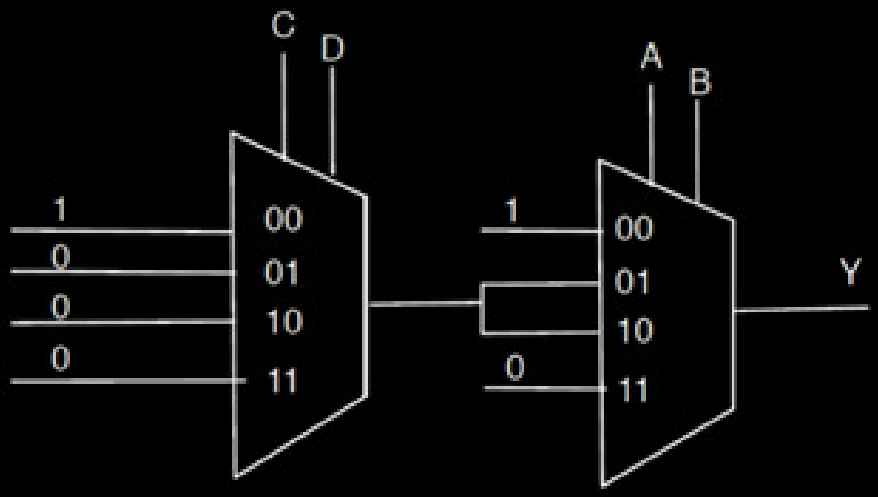


$$Y = \overline{B}\cdot\overline{C} + B\cdot D + \overline{B}\cdot\overline{D}$$

Helpful Hint



Question 3



C	D	Y
0	0	1
0	1	0
1	0	0
1	1	0

A	B	Y
0	0	1
0	1	X
1	0	X
1	1	0

	$\overline{C}\cdot\overline{D}$	$\overline{C}\cdot D$	$C\cdot D$	$C\cdot\overline{D}$
$\overline{A}\cdot\overline{B}$	1	1	1	1
$\overline{A}\cdot B$	1	0	0	0
$A\cdot B$	0	0	0	0
$A\cdot\overline{B}$	1	0	0	0

$$Y = \underline{A'B' + A'C'D' + B'C'D'}$$