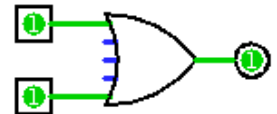
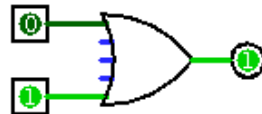
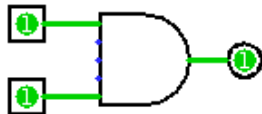
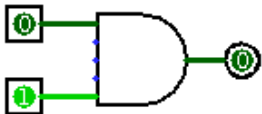
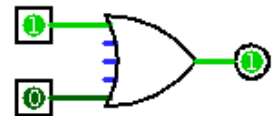
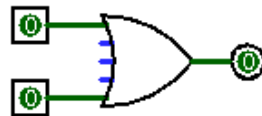
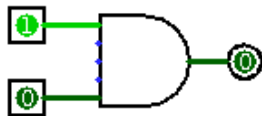
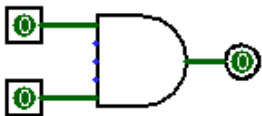


## Activity 2: Bits and Bytes

Computer hardware is made up of billions of tiny electronic circuits that use low and high voltages to represent the values 0 and 1. These binary digits, or “bits” for short, are the building blocks of all digital technology.

### Model 1 Logic Gates

*Complete the following tables based on the diagrams.*

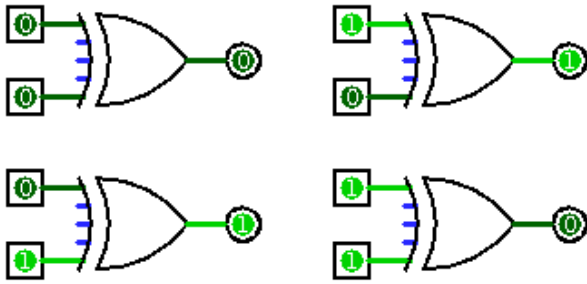


AND

Inputs	Output
0 0	
0 1	
1 0	
1 1	

OR

Inputs	Output
0 0	
0 1	
1 0	
1 1	



XOR

Inputs	Output
0 0	
0 1	
1 0	
1 1	

NOT

Input	Output
0	
1	

## Questions (10 min)

Start time: \_\_\_\_\_

1. In the circuit diagrams, what does the color (brightness) of the the lines represent?

2. For each type of gate, describe the circumstances when it will output the value 1.

AND:

OR:

XOR:

NOT:

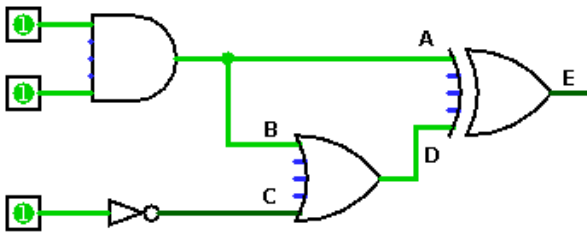
3. As a team, define the following words as they are used in everyday English.

logic:

gate:

4. Based on your definitions, what do you think a “logic gate” represents?

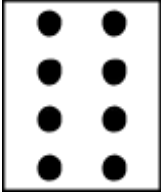



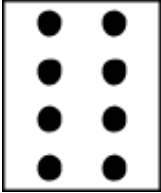



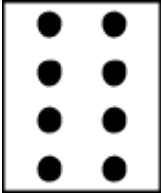
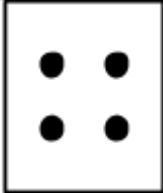


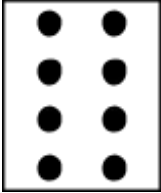
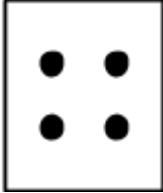


5. In the example circuit below, what are the values of  $A$ ,  $B$ ,  $C$ ,  $D$ , and  $E$ ?



6. How would  $A$ ,  $B$ ,  $C$ ,  $D$ , and/or  $E$  change if the top input were zero?

## Model 2 Binary Numbers

Each team has four cards that are ordered from the card with the most dots (8) to the card with the least dots (1). The cards represent four binary digits, or in other words, a 4-bit number.

Binary				Decimal
				
1	0	1	0	
				
1	0	1	1	
				
1	1	0	0	
				
1	1	1	1	

### Questions (15 min)

Start time: \_\_\_\_\_

7. In the table above, write the decimal value for each row by counting the number of dots.

- What is the largest decimal number that can be represented by four bits?
- What is the smallest decimal number that can be represented by four bits?
- How many possible decimal numbers can be represented by four bits?

8. Examine the binary notation below the cards. Explain in a full sentence what a 0 means about the card's dots and what a 1 means.

9. Complete the following table by writing the binary representation of the decimal numbers 0 to 15 using four bits. (And check your answers for #7.)

Decimal	Binary	Hex
0		0
1		1
2		2
3		3
4		4
5		5
6		6
7		7
8		8
9		9
10		A
11		B
12		C
13		D
14		E
15		F

10. *Hexadecimal* is shorthand for binary. For example, 0xD5 in hex is 1101 0101.

a) What is 0x2E in binary?

b) What is 0x74 in binary?

c) What is 0xB00 in binary?

d) What is 0xFAD in binary?

11. Based on the table in #9, explain why binary is sometimes referred to as base-2, decimal as base-10, and hexadecimal as base-16.

12. Explain the humor: “There are only 10 types of people in the world: those who understand binary, and those who don’t.”

13. Typically computers group 8 bits together at a time (8 bits are also called 1 *byte*). Fill in the number of dots for the four new cards:

				8	4	2	1
--	--	--	--	---	---	---	---

14. What is the largest number that can be represented by:

a) five bits?

b) six bits?

c) seven bits?

d) eight bits?

e)  $n$  bits?

15. Most computers built since the year 2000 have 64-bit processors. Before then, 32-bit processors were the norm. What is the advantage of having more bits?

**16.** In terms of logic gates and digital circuits, what is the disadvantage of having more bits?