

Light Bulb Binary

Background and Preparation

Here's an easy way to explore **binary**, a number system based on two (**bi-** = 2).

You Need:

Worksheet—Light Bulb Binary handout
Scissors

Introduction and Preparation

Students easily associate our **decimal** number system with the number ten. Ask the meaning of the root **dec-** (**dec-** = 10). Have students tell how many numerals we use in our decimal system (ten: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).

Discuss the root **bi-** = 2 and come up with some related words (bicycle, biceps, bipedal, . . .). Connect **bi-** with the word binary.

Pass out Light Bulb Binary worksheets. Have students cut along the dotted lines to get five pairs of light bulbs. Fold on the solid lines to create five light bulb cards with an "off" light bulb on one side of the card and an "on" light bulb on the other.

Tell students that you're tossing out all the numerals in the world except for two: 0 and 1.

Discuss how an electrical circuit only has two settings: "off" or "on."
Write on the board: off = 0 on = 1.

Have students note that the "off" light bulb card is labeled "off 0." The "on" light bulb card is labeled "on = 1." Binary is used in computers because electricity can be either on or off, nothing else.

Place Value: Decimals, Binary

Now introduce the place value chart. Since our decimal system is based on 10, you start with a 1 in the ones place, multiply by 10 and get the tens place, multiply that by 10 and get the hundreds place, and so on:

Decimal Place Value

10,000	1,000	100	10	1
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Binary place value works the same way. Start with a 1 in the ones place. Multiply 1 by 2 and get the twos place. Multiply 2 by 2 and get

the fours place. Multiply 4 by 2 and get the eights place. Multiply 8 by 2 and get the sixteens place, and so on:

Binary Place Value

16	8	4	2	1
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Create Binary Numbers

Have students place the five light bulb cards on the five columns of the place value chart on the worksheet with the "off" side showing.

Say, "Suppose we wanted to represent the numeral 2 with light bulbs. Looking at the place values, what light bulbs would we have to turn on?"

Wait while students figure this out by turning over the light bulb(s) needed.

Answer: You only need the light bulb in the twos place to be "on" ($2 = 0 + 2$).

In binary, a two is shown with the light bulb in the twos place "on" and the ones place "off." And "on, off" signals "10." It looks like a ten, but say "one zero."

"Use the light bulbs to show a five."

Answer: Turn on the light bulbs in the fours and the ones places to make a five ($4 + 0 + 1 = 5$).

For 5, the light bulbs read "on, off, on" or 101 ("one zero one").

"How about an 11?"

Answer: The light bulbs read "on, off, on, on" ($8 + 0 + 2 + 1 = 11$). It looks like 1011, "one zero one one."

Ask students to show you 28, 15, 36, 7.

Students can now work together to quiz each other.

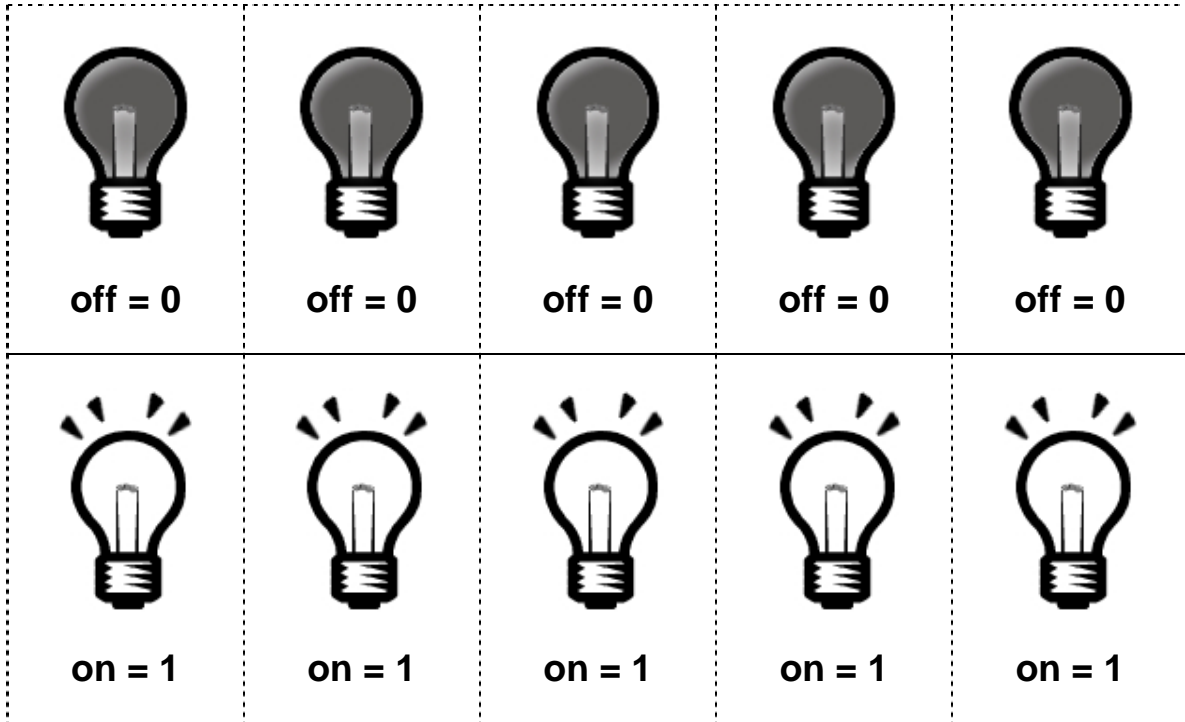
Have one student put a binary number on the board, such as 10101, and others figure out its decimal equivalent with the light bulb cards.

Ask, "What happens when we want to show a 38 or a 61 or 103?"

Students will follow the pattern on the place values chart to add columns (32, 64, 128, and so on).

Light Bulb Binary

Step 1: Cut out these five pairs of light bulbs cards on the dotted lines. **Do not cut on the solid lines.**



Step 2: Fold on the dotted lines so you have an “off” light bulb on one side of the card and an “on” light bulb on the other side of the card.

Binary Place Value Chart

16	8	4	2	1