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Student Activity Handout

*Introduction*

Scientists and engineers develop new digital technology every day. This technology can be seen in our cell phones or our computers or something as simple as your calculator. Understanding how this technology works is a valuable skill. This activity will expose you to how digital technology works and help prepare you for the digital world.

What are two examples of digital technology that you use every day (other than a cell phone, calculator, or computer)?

(1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (2) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*(Student answers will vary.)*

What two components will be used to design our digital circuit?

(1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (2) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*(4511 IC chip and a seven-segment display)*

Label the pin numbers for each component below.





*(Pin numbers are found in Figures 7 and 8.)*

*Circuit construction*

In this activity, you will apply binary numbers to the inputs of the 4511 decoder chip and you will observe how this decoder drives the display to show the right decimal numbers. A *decoder* is an integrated circuit component (i.e., IC chip) that takes in an input (variations of 1s and 0s) and generates an output based on the internal circuitry of the chip. For our 4511 decoder chip, we will have four inputs called A, B, C, and D. As we place different values for each of the input, the 4511 decoder chip will convert these values into signals that will “speak to” or drive the seven-segment display chip. In other words, the 4511 decoder chip contains the circuitry required to convert that binary input (i.e., A, B, C, D) to a decimal output (i.e., a number between 0 and 9).

Now let’s start constructing! Using the pin handouts and circuit schematics from your teacher, begin working through this table by applying either a 1 or a 0 to inputs A, B, C, and D. Remember if you want to apply a 1 to an input, you connect that wire to the red row of your breadboard (or the 9V). If you want to apply a 0 to an input, you connect that wire to the black row of your breadboard (or the 0V/ground).

Note: Notice that we have connected 560 ohm resistors between the outputs of the decoder and the display. These resistors limit the current that will circulate through the LEDs of the display. By changing their values, we can adjust the brightness of the display.

For each of the 10 binary inputs, draw the output that you see under “Draw Output.” Ask yourself—does this output give me what I would expect based on what I know about the binary input that I applied to my circuit?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Input A** | **Input B** | **Input C** | **Input D** | **Draw output** |
| 0 | 0 | 0 | 0 |  |
| 0 | 0 | 0 | 1 |  |
| 0 | 0 | 1 | 0 |  |
| 0 | 0 | 1 | 1 |  |
| 0 | 1 | 0 | 0 |  |
| 0 | 1 | 0 | 1 |  |
| 0 | 1 | 1 | 0 |  |
| 0 | 1 | 1 | 1 |  |
| 1 | 0 | 0 | 0 |  |
| 1 | 0 | 0 | 1 |  |

(Figure 5 contains the correct answers for the generated output in this table.)

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Rubric for assessment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 4 | 3 | 2 | 1 |
| Troubleshooting | Students spent considerable time checking to make sure that their connections were working properly before asking for assistance. | Students spent an adequate time checking to make sure that their connections were working properly before asking for assistance. | Students tried to troubleshoot but relied heavily on teacher intervention. | No troubleshooting took place. |
| Final circuit design | All pieces of the circuit design and binary table were accurate and worked as intended. | Most pieces of the circuit design and binary table were accurate and worked as intended. | Some pieces of the circuit design worked as intended or the binary table was incomplete. | No final circuit design was created and the binary table was not complete. |
| Sharing solutions | Both partners contributed equally to the sharing of group solutions, and the solutions were well-presented. | Both partners contributed to the sharing of group solutions, and the solutions were adequately presented. | One partner contributed to the sharing of group solutions, or the solutions were not fully developed when presented. | One partner contributed to the sharing of the solutions, or the solutions were not well-presented. |

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Engineering design process (EiE 2015)

