**Video explanation of solution is provided below the problem.**

## Two's Complement Representation

6/6 points (ungraded)

1) What is the decimal equivalent of the 6-bit binary two’s complement number 001000?

8

Answer: 8

Explanation

Each bit, except for the most significant bit (MSB), of a 2's complement number represents a power of 2 if that bit is set to 1, and 0 otherwise. Bit 0 represents (Bit0)*($2^0$) = 1 if Bit0 = 1 and 0 otherwise. Bit 1 represents (Bit1)*($2^1$) = 2 if Bit1 = 1 and 0 otherwise. Bit 2 represents (Bit2)*($2^2$) = 4 if Bit2 = 1 and 0 otherwise, and so on. The MSB of the 2's complement represents -(BitX)*($2^{(X-1)}$). So in a 6 bit 2's complement number the MSB (bit 5) represents 0 if its 0 and $-2^5$ if its a 1.
For this problem, there is only one 1 in our binary number in bit 3, which corresponds to $2^3$ = 8.

2) What is the decimal equivalent of the 6-bit binary two’s complement number 101100?

-20

Answer: -20

Explanation

Each bit, except for the most significant bit (MSB), of a 2's complement number represents a power of 2 if that bit is set to 1, and 0 otherwise. Bit 0 represents (Bit0)*($2^0$) = 1 if Bit0 = 1 and 0 otherwise. Bit 1 represents (Bit1)*($2^1$) = 2 if Bit1 = 1 and 0 otherwise. Bit 2 represents (Bit2)*($2^2$) = 4 if Bit2 = 1 and 0 otherwise, and so on. The MSB of the 2's complement represents -(BitX)*($2^{(X-1)}$). So in a 6 bit 2's complement number the MSB (bit 5) represents 0 if its 0 and $-2^5$ if its a 1.
In this problem, there are ones in bit 2, 3, and 5 of our 6-bit 2's complement number. This means that the number is = $-2^5 + 2^3 + 2^2 = -32 + 8 + 4 = -20$.

3) Using a 6-bit two’s complement representation, what is the range of integers that can be represented with a single 6-bit quantity? Provide your response in decimal notation.

Range of integers: min -32 Answer: -32 max 31

Answer: 31

Explanation

The smallest number that can be represented using 6-bit two's complement is 0b100000. This is equal to -32 in decimal. To figure this out, one can flip all the bits and add 1. Flipping all the bits results in 0b011111 and adding 1 to that results in 0b100000 which we interpret as an unsigned number in order to figure out the value of our original number. The value of this number is $2^5 = 32$, hence our original number was -32.
The largest number that can be represented using 6-bit two's complement is 0b011111. This number is equal to $2^4+2^3+2^2+2^1+2^0 = 16+8+4+2+1 = 31$.

4) What is the result of the following subtraction problem in 6-bit two's complement representation?

15 - 18 = 0b

111101

✔ Answer: 111101

Explanation
15 = 001111 in 6-bit 2's complement.
18 = 010010.
To find the binary representation of -18, you need to flip all the bits and add 1 to the +18 two's complement representation.
-18 = 101101 + 1 = 101110
Addition in binary follows the same rules as addition in decimal. So we will begin by adding the two least significant bits in the binary representation, record the result as well as keep track of any carry into the next column. This is done repeatedly for each column from the least significant to the most significant. If there is a final carry that goes beyond the number of bits in our 2's complement adder, that final carry is dropped.
The result we get when performing this addition in this manner is 111101.
To verify that this is the correct answer, we find its decimal equivalent by flipping all the bits and adding 1, 000010 + 1 = 000011 = 3, therefore our result of 111101 = -3 which is the expected result.

27 - 6 = 0b

010101

✔ Answer: 010101

Explanation
27 = 011011 in 6-bit 2's complement.
6 = 000110.
To find the binary representation of -6, you need to flip all the bits and add 1 to the +6 two's complement representation.
-6 = 111001 + 1 = 111010
Addition in binary follows the same rules as addition in decimal. So we will begin by adding the two least significant bits in the binary representation, record the result as well as keep track of any carry into the next column. This is done repeatedly for each

column from the least significant to the most significant. If there is a final carry that goes beyond the number of bits in our 2's complement adder, that final carry is dropped.
The result we get when performing this addition in this manner is 010101.
010101 = 16 + 4 + 1 = 21 which is the expected result of subtracting 6 from 27.

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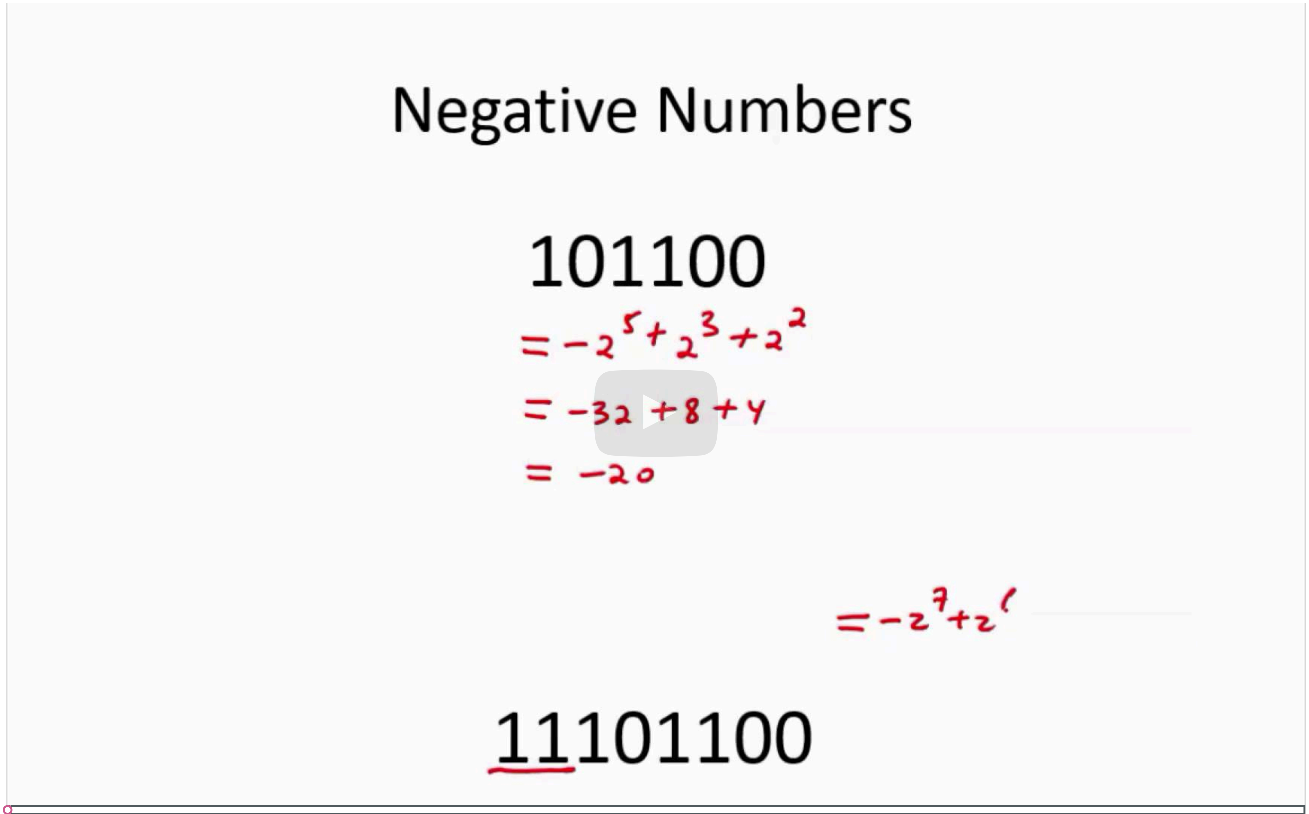
Answers are displayed within the problem

## Two's Complement Representation




0:00 / 0:00 1.0x

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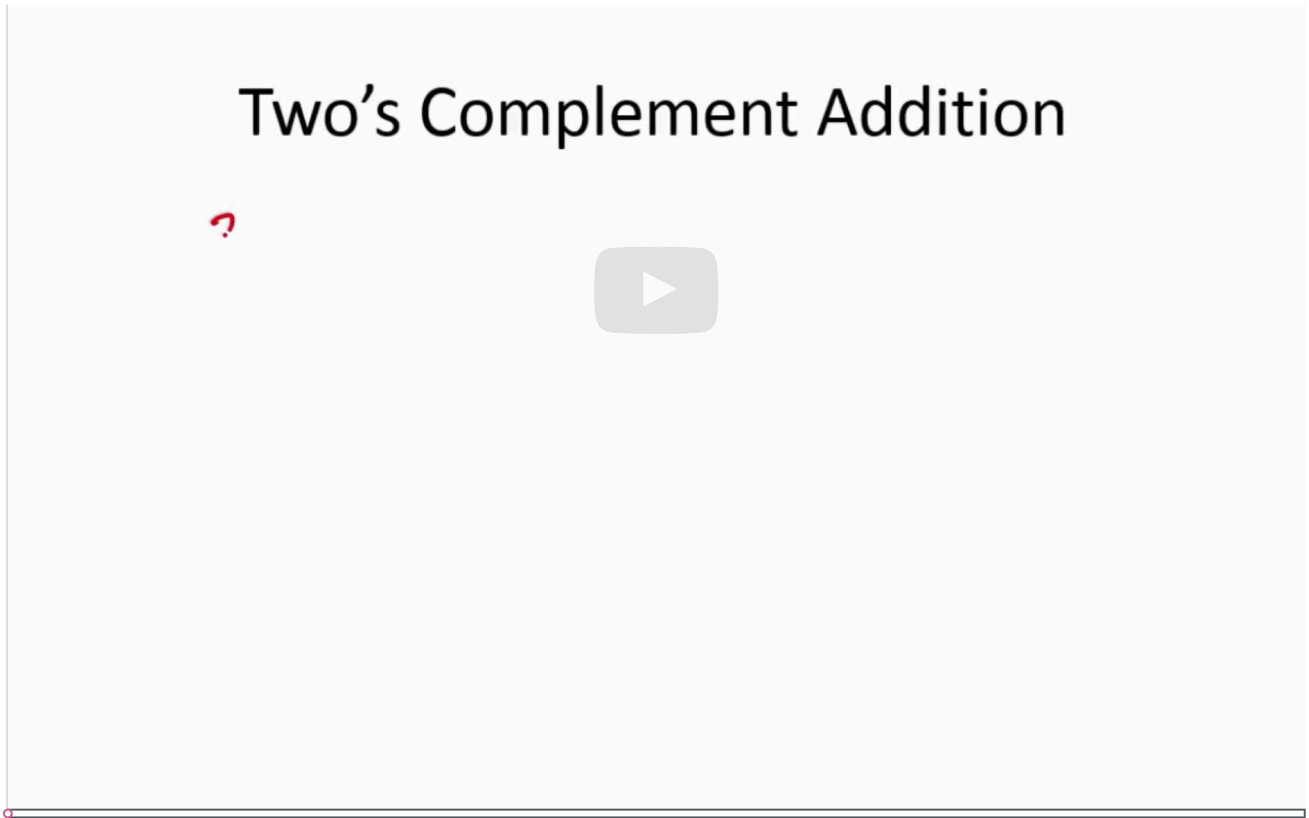
## Two's Complement Addition




0:00 / 0:00 1.0x

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  Hi am John and am new here. I dont knw anything about computer science but i want to knw more... — 1
- V_in in second question
  ***[STAFF]*** I couldn't really understand the question. Help plz (The output voltage of an inverter... — 2
- Binary function
  ***[STAFF]***strong text1. How many binary functions of two (binary) inputs are there? (You can ... — 2
- I dont understand how they add 1
  Around the 58 second mark to the 1:03 mark i get they flip the numbers for positive 18 to get -18. ... — 3
- A retired journalist and a student in computing — 2

Hi, I am Tony Ngan, a retiree living in the Hong Kong Special Administrative Region, China. I used t...

HW#1 question 1
Hi, I'm stuck on the first question in the homework. Please can someone explain what to actually d... 5

[STAFF]
Good morning, My name is Victor. Please, let me know where i can find Jade in order to complete ... 2

Any prerequisites to this course?
Are there any prerequisites to this course, would anyone know? I am a second year computer prog... 2

Sea o' quids board
Hey everyone, my name is Rene from Mexico and I'm here to learn stuff for fun. This course looks v... 2

greetings from Costa Rica
Mauricio Chinchilla from Costa Rica. Hei¡ 2

Prerequisites (x2)
I am a junior high school student from the United States, and have only completed basic physics (e... 4