

## Even and Odd Algebra Problems

When doing algebra problems, sometimes we are asked to prove something is true for an even number or that something is true for an odd number. The “something” we are trying to prove may *only* be true for even numbers and not necessarily true for odd numbers. So how do we represent even numbers in algebra? Well, what does it mean to be an even number? It means that the number is divisible by 2. So if a question asks us about an even number, we can represent it by  $2n$ .

We usually think of odd numbers as being defined as “not divisible by 2” or just “any number that isn’t even”. Well, we can be a bit more precise and say that odd numbers are numbers that are 1 greater than an even number. So they can be represented as  $2n + 1$ . If you wanted, you could instead say that odd numbers are the numbers that are 1 less than even numbers. In that case, you would use  $2n - 1$ . Either form will get you the right answer.

Now, let’s look at an example of a question involving even and odd numbers.

Prove that an even number multiplied by an odd number will always be even.

$$\begin{aligned}(2n)(2k + 1) \\ &= 4kn + 2n \\ &= 2(2kn + n)\end{aligned}$$

We can see that our final answer is 2 multiplied by a polynomial, so the number is even and our proof is done. But what if we had used  $2k - 1$  instead of  $2k + 1$ ?

Let’s see:

$$\begin{aligned}(2n)(2k - 1) \\ = 4kn - 2n \\ = 2(2kn - n)\end{aligned}$$

We still get 2 multiplied by a polynomial, but our polynomial is different. We've still shown that we get an even number, so our proof is just as valid.

Try these questions on your own:

1. An even number squared will be even
2. An odd number squared will be odd
3. The sum of two even numbers is even
4. The sum of two odd numbers is even
5. The sum of three odd numbers is odd
6. The difference between two odd numbers is even
7. The difference between an even number and an odd number is odd
8. Any multiple of 14 is even
9. A square with an odd integer as a side length will have an odd area

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