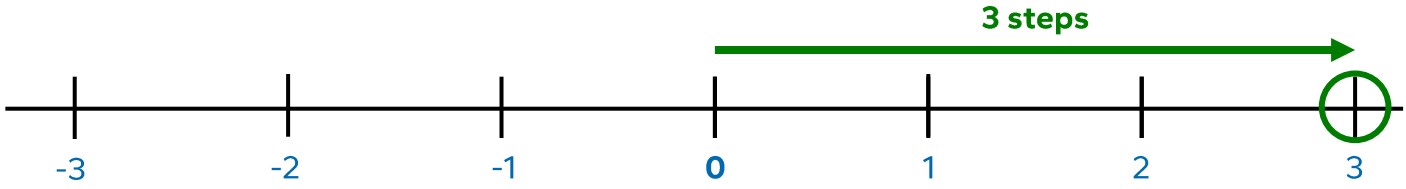
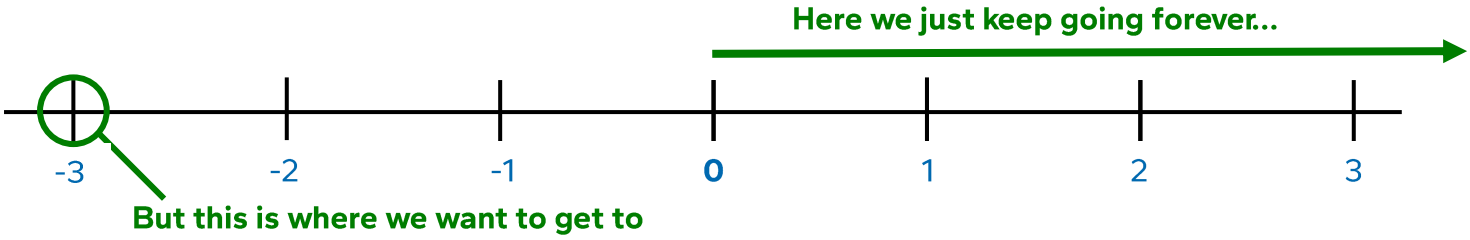
Working with Minus Signs

What does a minus sign mean?

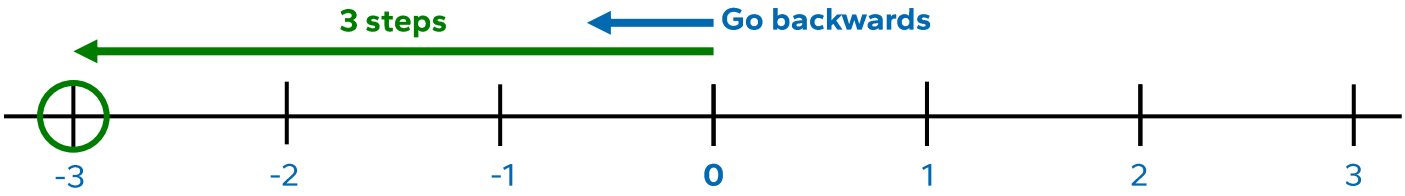
When we want to count to a number, say 3, we start at 0 and move forward 3 steps along the number line:



But what if we wanted to count to **minus** 3? We can't do this by moving forward along the number line, because we'd never reach -3:



The problem is clear – we're going the wrong way! So instead of counting forwards, to get to -3, we have to count **backwards**:



The minus sign in front of the 3 is telling us to **go backwards** – you can also think of this as **turning around** before taking the steps. In general:

A minus sign means '**go backwards**' or '**turn around**'.

Adding numbers

When we add two numbers together, we **count to the first number** and then **move forward the number of steps given by the second number**.

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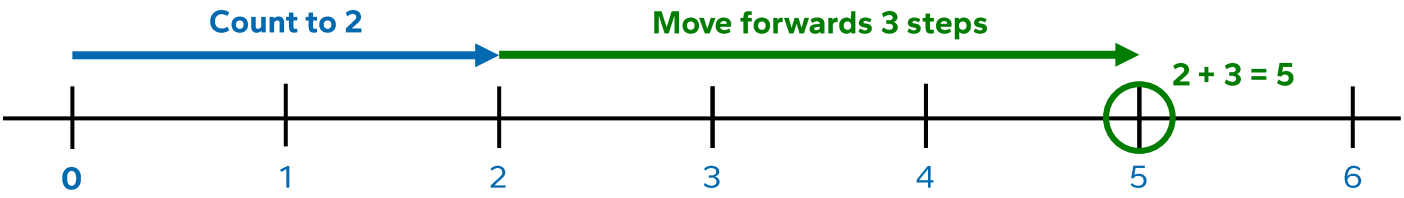
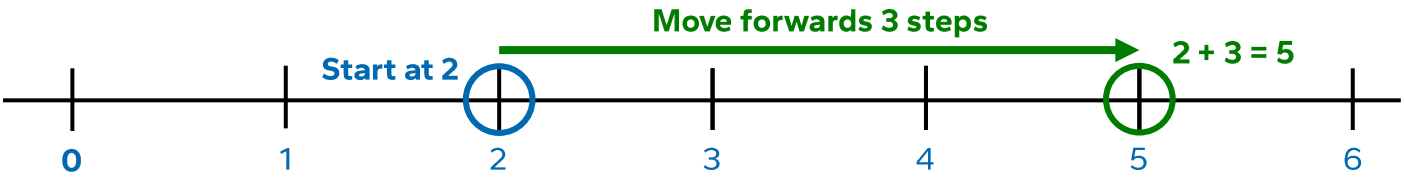
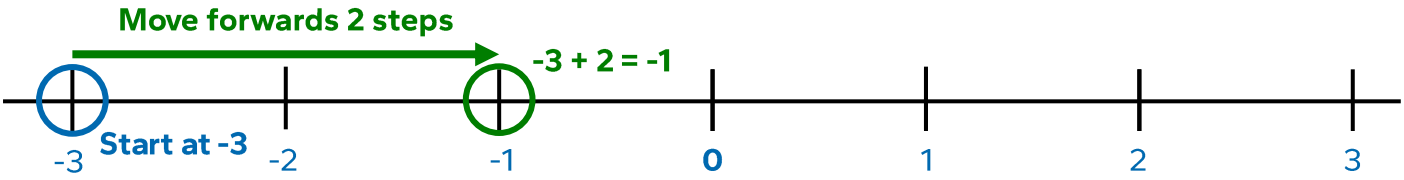
For example, 2 + 3 means '**count to 2**, then **move forwards 3 steps**':



Notice that this is the same as saying '**start at 2** and then move forwards 3 steps':



We can follow this procedure when the **first number** is **negative** as well. For example, -3 + 2 means 'start at -3 and move forwards 2 steps':

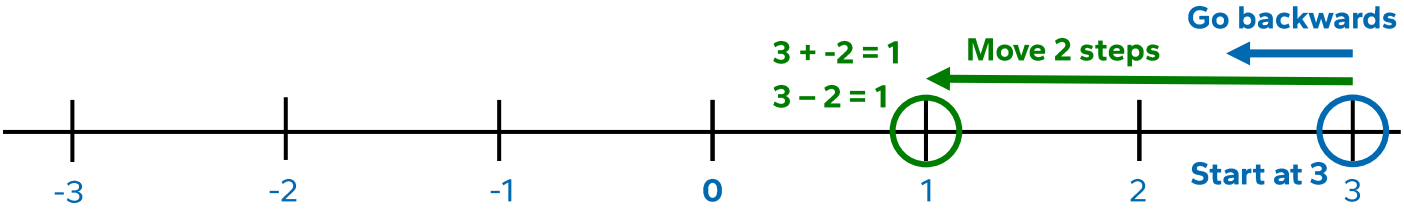


Adding by a negative number

If we wanted to calculate 3 + -2 using the procedure above, we would read this as 'Start at 3, and move forwards minus two steps'. But what does it mean to move forwards by minus two steps?

Remember that the minus sign tells us to **go backwards**! In other words, we need to **go backwards** and **then** move two steps.

So 3 + -2 should be read as 'start at 3, **go backwards** and move 2 steps':



We can then shorten the + - above to just a -, so the above calculation can be written as '3 **–** 2', or '3 **subtract** 2'. We can also write this as '3 **- +**2', as 2 can also be written as **+**2. In general:

Subtracting is the same as **adding by a negative number**.

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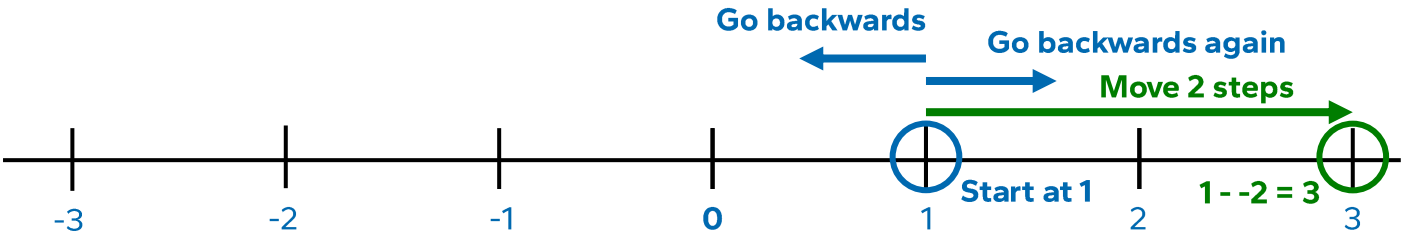
Subtracting a negative number

When we subtract a negative number, we read this in the same way as we've done so far, remembering that **every time we see a minus sign**, we need to **turn around** or **go backwards**.

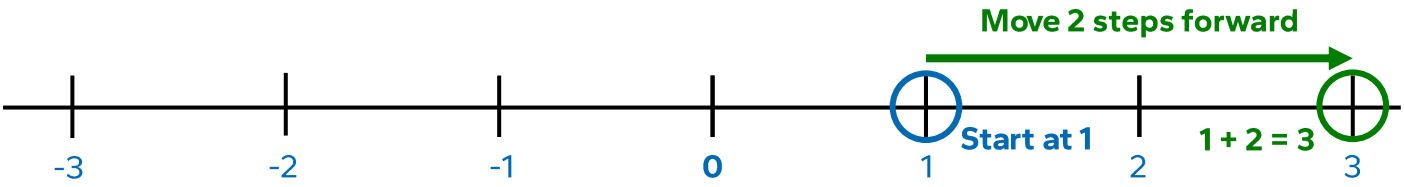
For example, if we want to calculate 1 - -2, we would read this as follows:

- Start at 1.
- Turn around/go backwards (as indicated by the **first** minus sign).
- Turn around/go backwards **again** (as indicated by the **second** minus sign).
- Move 2 steps.

Notice that when we turn around, and then turn around again, we end up **facing forwards again**, so we actually move **forwards** two steps:



Notice that this is the same as just doing 1 + 2:



This means that **two minuses together** are **equivalent to a plus**, i.e. **- -** is equivalent to **+**.

Key points to remember

- '+ +' is the same as '+'
- '+ -' is the same as '-'
- '- +' is the same as '-'
- '- -' is the same as '+'

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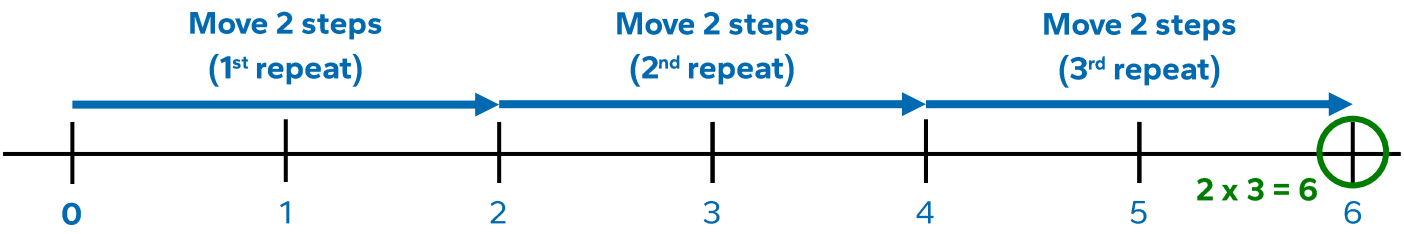
Multiplying and dividing negative numbers

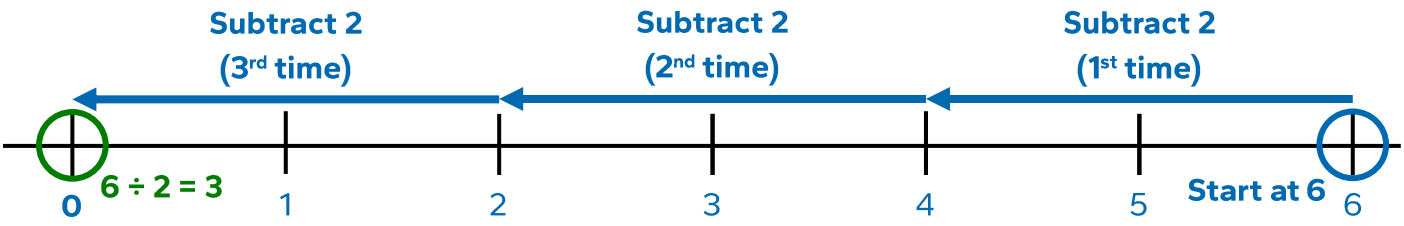
Fundamentally, multiplication is the same as repeated addition. For example, multiplying 2 by 3 is the same as adding 2 to itself repeatedly until we have three 2s:

$$2 \times 3 = 2 + 2 + 2 \ (3 \ 2s)$$

So we can read 2×3 as 'start at 0, **move forwards 2 steps** and **repeat this 3 times**':



Similarly, division is repeated subtraction – we keep subtracting the second number from the first number until we reach 0. For example, $6 \div 2 = 3$ because we have to subtract 2 from 6 a total of 3 times to reach 0:



When we apply this to a negative number, however, such as 2×-3, we would read this as '**move forwards 2 steps** and **repeat this minus 3 times**'. We can't do this, because repeating something minus 3 times doesn't make any sense.

Neither does it make sense to read this as 'move forwards 2 steps, go backwards and repeat this 3 times' – if we did this, we would just move back and forth between 0 and 2 and end up with the wrong answer of 2.

Instead, when we multiply with negative numbers, we have to apply the minus signs, going backwards once for every minus sign, **before** we do the multiplication.

This means that when we multiply with negative numbers, we need to do the following:

1. Move all of the minus signs **to the front**.
2. Turn around/go backwards **once** for every minus sign we encounter.
3. Move the set number of steps the set number of times **in the direction we're currently going in**.

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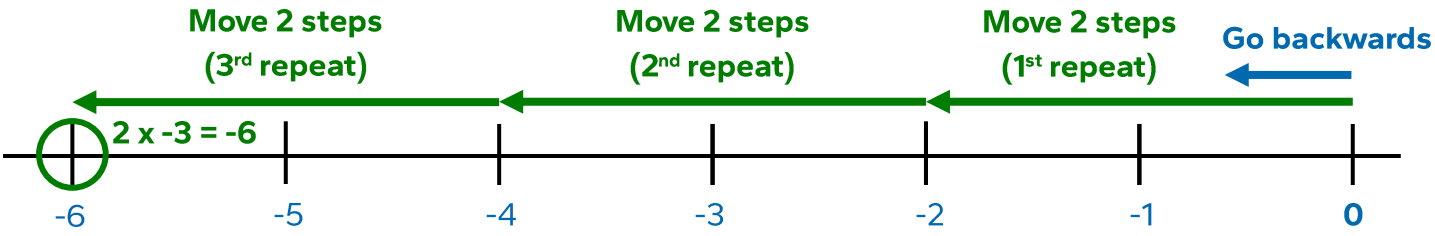
Example

To calculate 2×-3, we:

1. **Move the minus sign to the front** to get $-(2 \times 3)$.
2. As there's **one** minus sign, we **go backwards once** (so we're now going backwards).
3. Move 2 steps 3 times.

When we do this, we obtain the correct answer of -6:



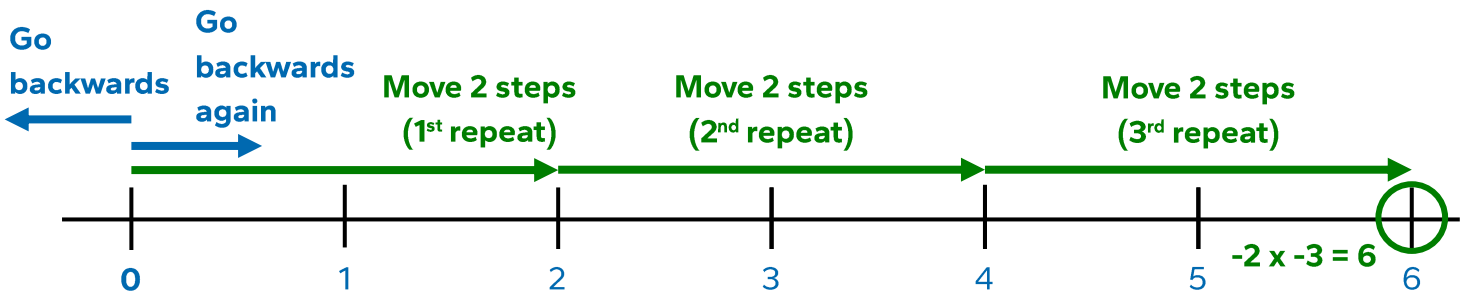
Practice Exercise

Use the procedure above to calculate -2×3, -3×2 and 3×-2, and convince yourself that all three of these calculations are the same as 2×-3.

We can use exactly the same procedure to multiply **two negative numbers** together. For example, to calculate -2×-3, we:

1. **Move the minus signs to the front** to get $- - (2 \times 3)$.
2. Turn around/go backwards (as indicated by the **first** minus sign – we're now going **backwards**).
3. Turn around/go backwards **again** (as indicated by the **second** minus sign – we're now going **forwards again**).
4. Move 2 steps 3 times.

Notice that as we end up going forwards, this is the same as calculating 2×3, so in step 1 above, we could use the *'- -' is the same as '+'* rule we saw earlier to turn the two minus signs into a +:



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We can use a similar process to **divide** with negative numbers.

For example, to calculate $6 \div -2$, we:

1. **Move the minus sign to the front** to get $-(6 \div 2)$.
2. **Perform the division in the brackets** $(6 \div 2)$ to get 3.
3. We still have the minus sign at the front, so add this on to get the final answer of **-3**.

Practice Exercise

Use the procedure above to calculate $-6 \div 2$, and convince yourself that this is the same as $6 \div -2$.

And to calculate $-6 \div -2$, we:

1. **Move the minus signs to the front** to get $- - (6 \div 2)$.
2. Convert the $- -$ into a $+$ to get $+(6 \div 2)$ (i.e. just $6 \div 2$)
3. **Perform the division in the brackets** $(6 \div 2)$ to get 3.
4. We don't have any more minus signs to deal with, so the final answer is **3**.

Practice Exercise

Perform the following calculations:

1)

a. $1 + 1$	d. $-3 + 0$	g. $-5 + 3$	j. $-4 + 8$
b. $-7 + 4$	e. $3 + 7$	h. $-3 + 8$	k. $-2 + 8$
c. $-5 + -6$	f. $1 + -10$	i. $4 + 7$	l. $10 + 5$

2)

a. $-9 - -10$	d. $6 - 9$	g. $-3 - 7$	j. $-3 - -5$
b. $-10 - 5$	e. $9 - 4$	h. $4 - -1$	k. $10 - 6$
c. $-9 - 4$	f. $-5 - 0$	i. $5 - 9$	l. $7 - -6$

3)

a. 1×1	d. -4×3	g. 4×-8	j. -3×-5
b. 3×-4	e. 3×3	h. 10×6	k. 10×7
c. -3×-10	f. -10×4	i. -9×-7	l. -3×1

4)

a. $8 \div 2$	d. $-63 \div -7$	g. $36 \div 4$	j. $80 \div -10$
b. $-8 \div 2$	e. $-50 \div 5$	h. $20 \div 5$	k. $-72 \div -9$
c. $12 \div 6$	f. $-24 \div 3$	i. $2 \div -2$	l. $10 \div -5$

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