MATHEMATICS · GRADES 10-12

# Scalar multiplication

### Difficulty level: Advanced

### Mathematics: Grades 10-12

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## *Overview of the concept*

This is how a video game or a map app makes a direction arrow twice as long or flips it around, by multiplying every part of it by one number. A game developer doubles a character's speed by scaling its movement vector, keeping the direction and changing only the size. A map app zooms in by scaling every distance on the screen by the same factor. Knowing scalar multiplication tells you how one number can stretch, shrink, or reverse a whole direction at once.




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## *Rule*

### Scalar multiplication: to multiply a vector by a number, multiply every component of the vector by that number.

A positive number keeps the direction, a negative number reverses it, and zero gives the zero vector.

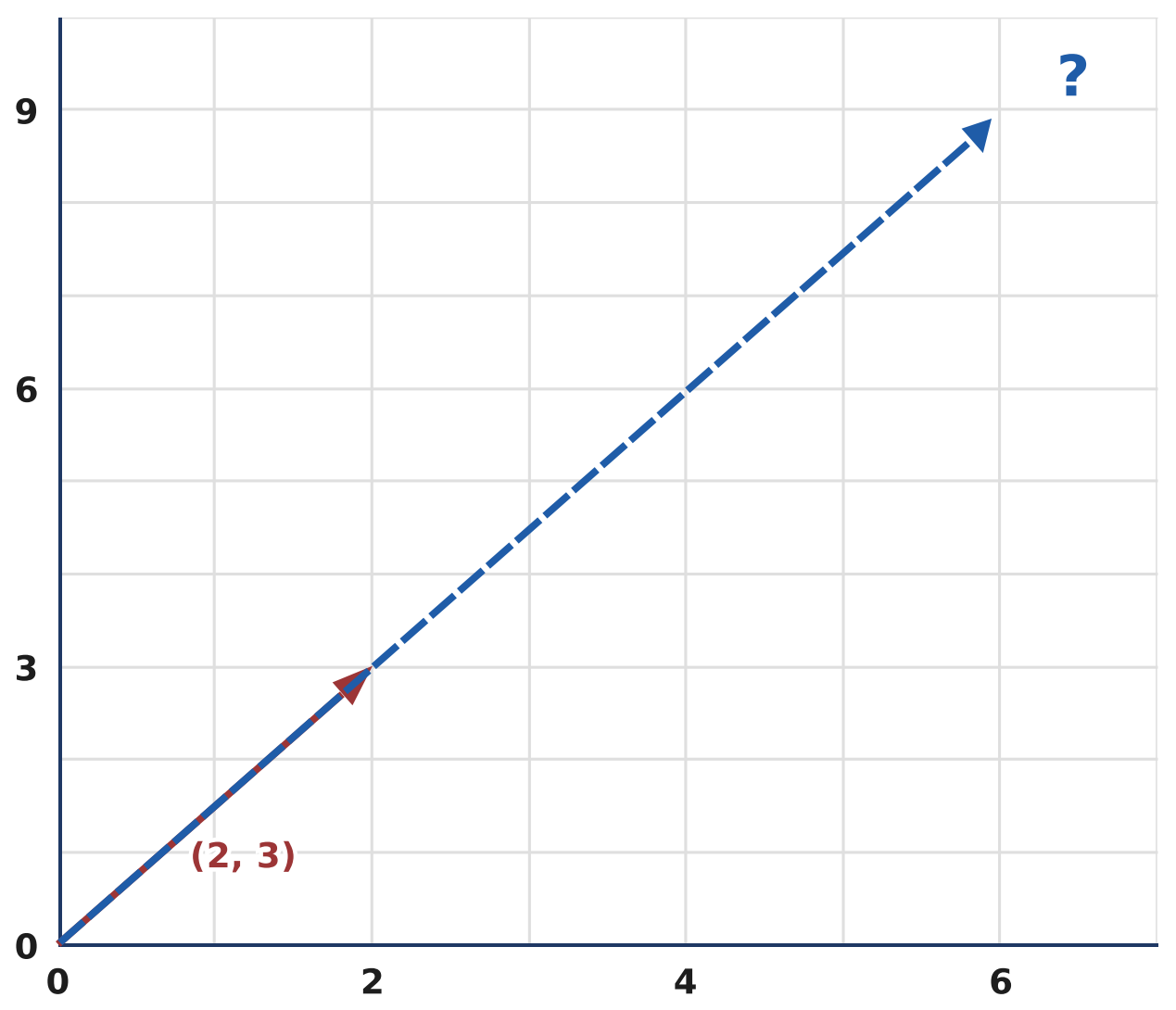



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## Worked examples

EXAMPLE 1

**Q** Multiply (2, 3) by 3.




SOLUTION

Multiply the x component:

$2 \times 3 = 6$

Multiply the y component:

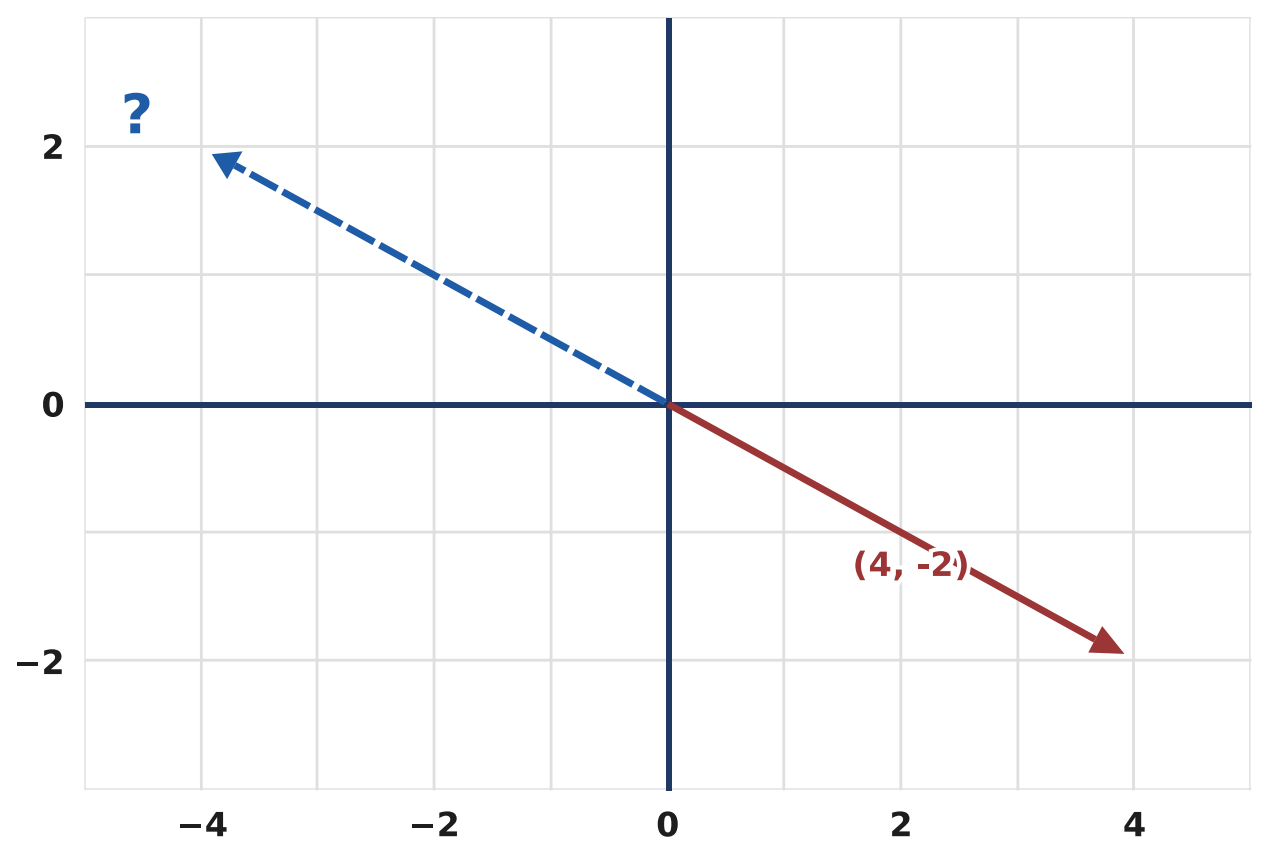
$3 \times 3 = 9$

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The result is (6, 9).

EXAMPLE 2

## Q Multiply (4, -2) by -1.




### SOLUTION

Multiply each component by -1:

-1 × (4, -2) = (-4, 2)

The length stays the same but the direction reverses.

The result is (-4, 2).

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## Practice questions

**1** What is $2 \times (1, 5)$?

- **A** (10, 2)
- **B** (2, 10)
- **C** (2, 5)
- **D** (1, 5)

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**2** What is $0 \times (3, 4)$?

- **A** (3, 4)
- **B** (0, 0)
- **C** (0, 4)
- **D** (3, 0)

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**3** What is $\frac{1}{2} \times (2, 6)$?

- **A** (1, 3)
- **B** (2, 6)
- **C** (1, 6)
- **D** (4, 12)

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**4** What is $-2 \times (5, 1)$?

- **A** (10, 2)
- **B** (-10, 2)
- **C** (-10, -2)
- **D** (-5, -1)

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**5** What is $-\frac{1}{2} \times (6, -4)$?

- **A** (-3, 2)
- **B** (3, -2)
- **C** (-3, -2)
- **D** (3, 2)

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**6** What number multiplies (2, 4) to give (6, 12)?

- **A** 3
- **B** 2
- **C** 6
- **D** 12

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**7** What is $3 \times (0, 8)$?

- A (0, 8)
- B (0, 24)
- C (24, 0)
- D (0, 72)

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**8** If $3v = (9, -6)$, what is v?

- A (3, -2)
- B (27, -18)
- C (9, -6)
- D (3, 2)

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**9** Which number reverses the direction of (4, 4) but keeps its length?

- A -1
- B 1
- C 0
- D 2

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**10** Multiply (5, 1) by -2, then multiply the result by $\frac{1}{2}$. What is the final vector?

- A (-5, -1)
- B (5, 1)
- C (-10, -2)
- D (-5, 1)

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## ANSWER KEY

**1.** (2, 10)

**2.** (0, 0)

**3.** (1, 3)

**4.** (-10, -2)

**5.** (-3, 2)

**6.** 3

**7.** (0, 24)

**8.** (3, -2)

**9.** -1

**10.** (-5, -1)

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