

Multiplication of Vectors by Real Numbers

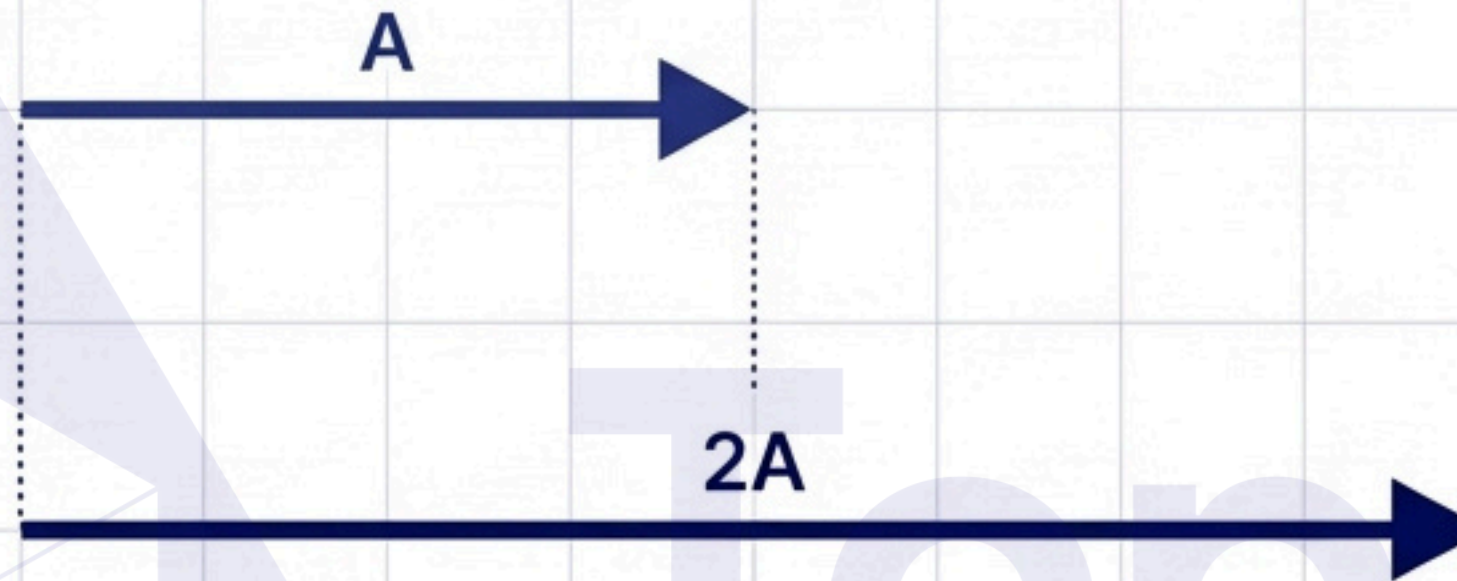


Learn how scalar multipliers alter the magnitude, direction, and physical dimensions of vectors.

$$[\lambda \mathbf{A}]$$

-> Swipe or press next to begin.

Scaling Magnitude in the Same Direction



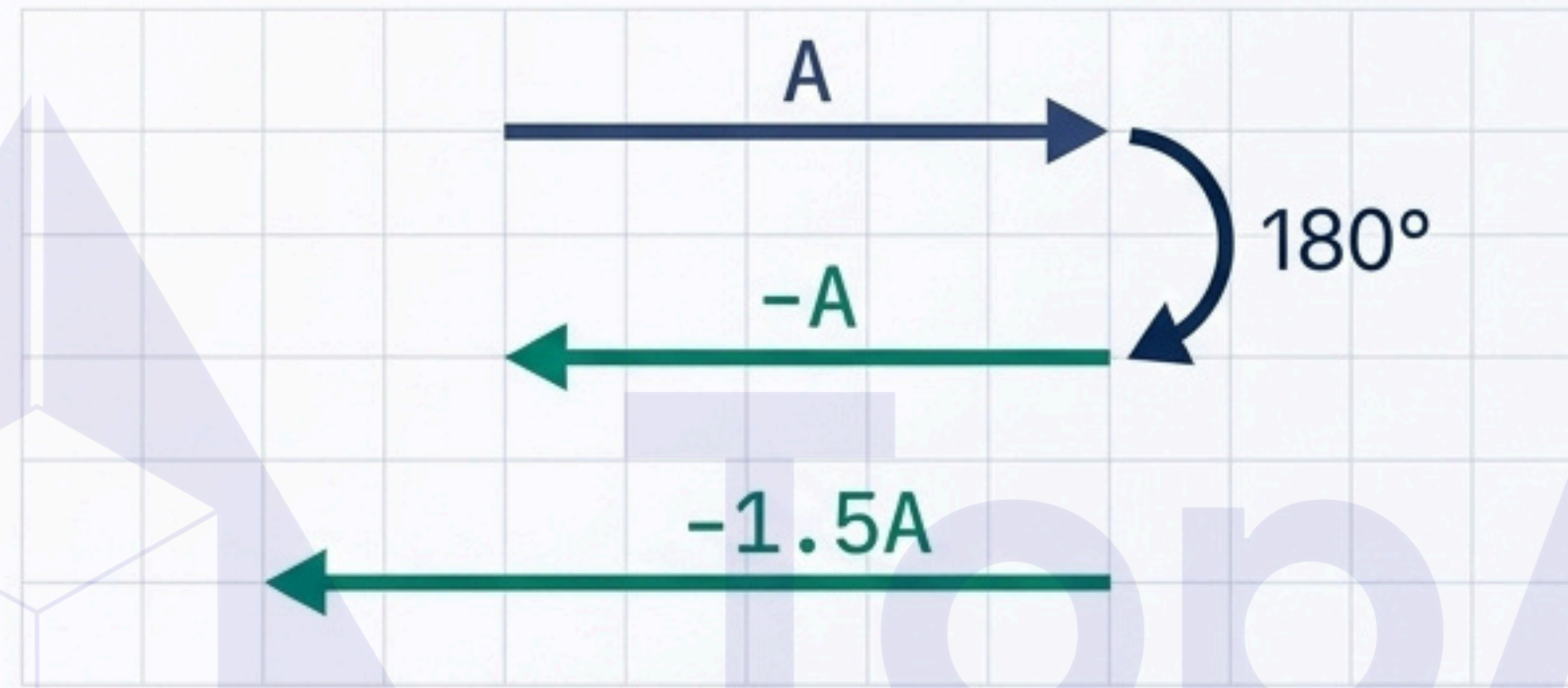
Multiplying a vector by a positive number ($\lambda > 0$) changes only its magnitude. The direction remains entirely unchanged.

The new magnitude is exactly λ times the original magnitude.

$$|\lambda \mathbf{A}| = \lambda |\mathbf{A}| \quad (\text{if } \lambda > 0)$$

Positive multipliers stretch or shrink the vector without altering its path.

Reversing Direction While Scaling



The negative sign (-) acts as a directional switch. It perfectly reverses the vector's direction by 180°.

The numerical absolute value (e.g., 1.5) independently scales the magnitude, just like a positive scalar.

$$|-\lambda A| = \lambda |A| \text{ (Reversed Direction)}$$

A negative scalar always results in a complete directional flip.



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$$E=mc^2$$



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The Rules of Scalar Multiplication

Scalar Type	Effect on Magnitude	Effect on Direction
Positive ($\lambda > 0$)	Scales by λ	No Change (Parallel)
Negative ($-\lambda < 0$)	Scales by $ \lambda $	Reversed (Anti-parallel)
Zero ($\lambda = 0$)	Becomes 0	Undefined (Null Vector)

A scalar is just a real number. It acts as an operator that transforms the base vector according to these strict geometrical rules.

$$\text{Resultant Vector} = \text{Operator} \times \text{Base Vector}$$

Master this table to instantly predict vector transformations.

When Scalars Carry Physical Dimensions

$$[\text{Velocity Vector (m/s)}] \times [\text{Time Scalar (s)}] = [\text{Displacement Vector (m)}]$$



The multiplier λ isn't always a dimensionless number. It can be a physical quantity with its own units (like time or mass).

The final vector inherits the mathematical product of the base vector's dimensions and the scalar's dimensions.

$$[\text{Dimension of } \lambda A] = [\text{Dimension of } \lambda] \times [\text{Dimension of } A]$$

Multiplying a vector by a dimensional scalar creates an entirely new physical quantity.

Exam-Smart Summary

$$\mathbf{A} \rightarrow 2\mathbf{A}$$



$$\mathbf{A} \rightarrow -0.5\mathbf{A}$$



$$\mathbf{v} \times \mathbf{t} \rightarrow \mathbf{r}$$

$$\text{m/s} \times \text{s} = \text{m}$$

1. **Magnitude:** Scaled by the absolute value of the real number multiplier.
2. **Direction:** Preserved by positive numbers, fully reversed by negative numbers.
3. **Dimensions:** The new vector is the dimensional product of the scalar and the original vector.

$$\mathbf{A} \times \lambda = \lambda \mathbf{A}$$

You're ready to apply scalar multiplication in kinematics and forces.



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