SCIENCE FOUNDATIONS

# Acceleration

### Difficulty level: Intermediate

### Science Foundations

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## *Overview of the concept*

This is how you describe how quickly a car speeds up when you press the gas, slows down when you brake, or changes direction around a corner. A car pulling away from a light, a bike speeding up downhill, and a runner sprinting off the line are all accelerating, even though only one of them is a car. Turning a corner counts too, since changing direction is a change in velocity even if the speed stays the same. Acceleration is not just going faster, it is any change in how fast or in which direction something is moving.




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## *Rule*

**Acceleration: acceleration is any change in velocity over time. $a = \frac{\text{change in velocity}}{\text{time}}$.**

Velocity includes direction, so speeding up, slowing down, and turning at constant speed are all acceleration.

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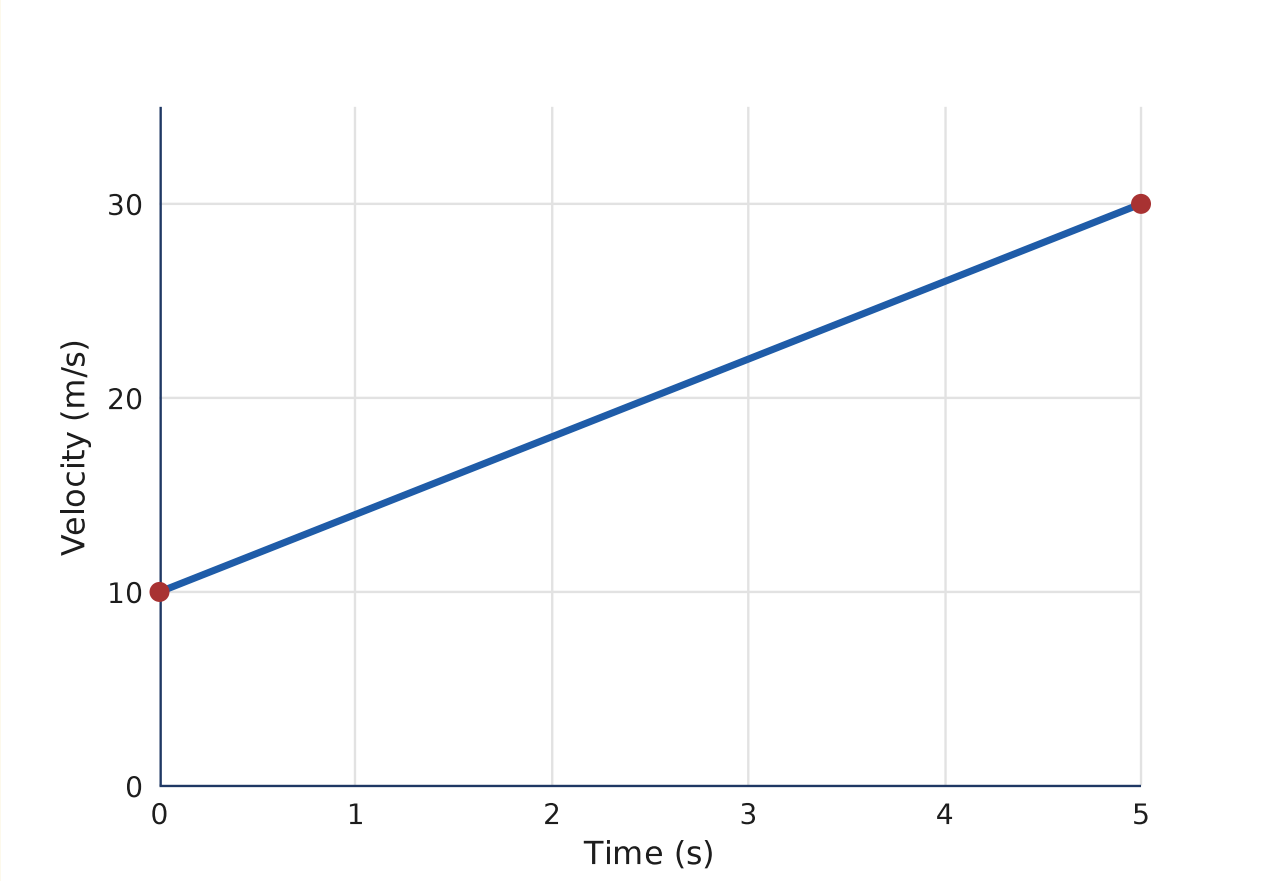
## Worked examples

EXAMPLE 1

**Q** A car speeds up from 10 m/s to 30 m/s in 5 s. Acceleration?




**SOLUTION**

Change in velocity: 30 - 10 = 20 m/s

Divide by time: 20 ÷ 5 = 4

$a = 4\ m/s^2$

The result is $4\ \frac{m}{s^2}$.

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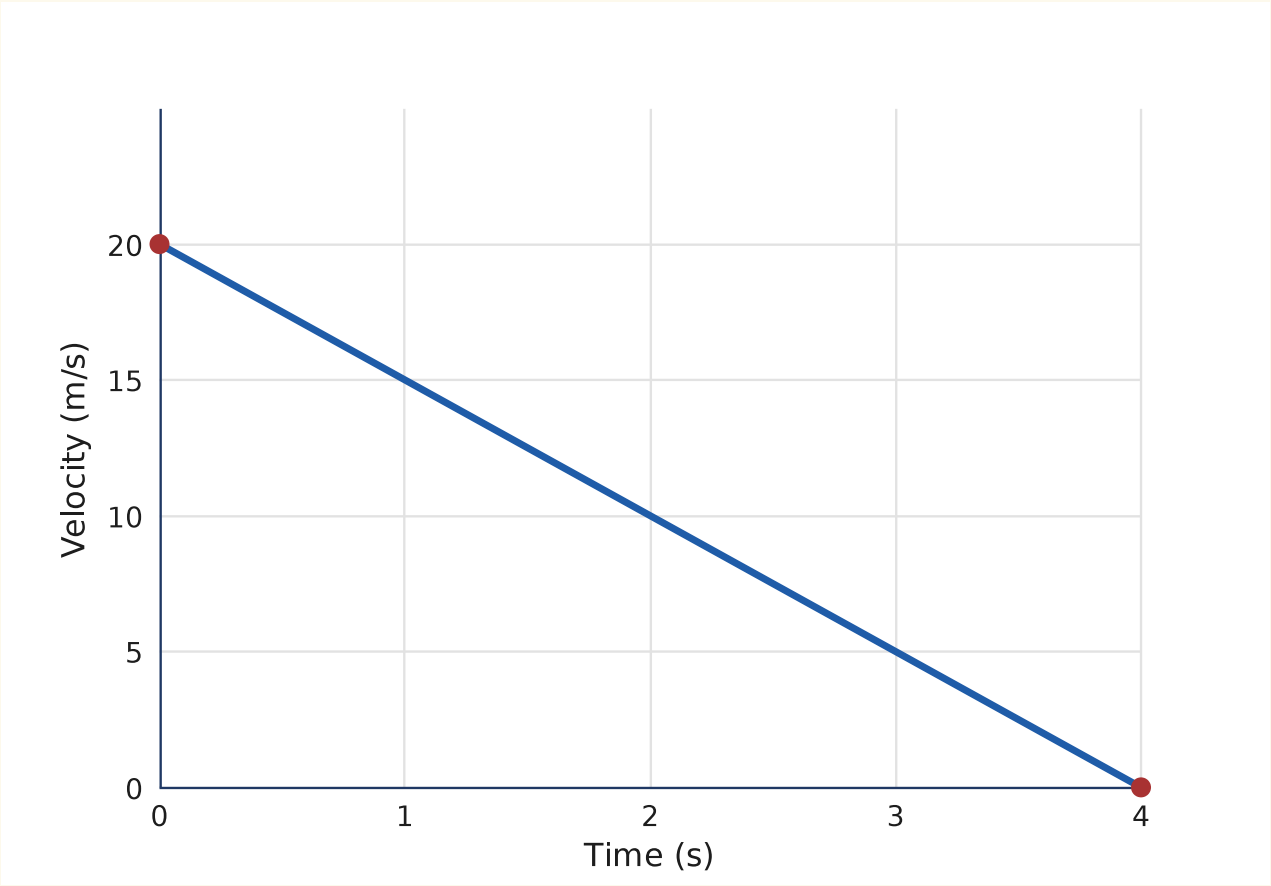
EXAMPLE 2

## Q A car slows from 20 m/s to 0 m/s in 4 s. Acceleration?




### SOLUTION

Change in velocity: 0 - 20 = -20 m/s

Divide by time: -20 ÷ 4 = -5

$a = -5\ m/s^2$

The result is -5 $\frac{m}{s^2}$ (deceleration of 5 $\frac{m}{s^2}$).

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## Practice questions

**1** A train speeds up from 5 m/s to 25 m/s in 4 seconds. What is its acceleration?

- **A** $4\,\frac{m}{s^2}$
- **B** $5\,\frac{m}{s^2}$
- **C** $6.25\,\frac{m}{s^2}$
- **D** $7.5\,\frac{m}{s^2}$

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**2** **A cyclist brakes from 12 m/s to a stop in 6 seconds. What is her acceleration?**

- **A** $-2\frac{m}{s^2}$
- **B** $2\frac{m}{s^2}$
- **C** $-6\frac{m}{s^2}$
- **D** $-12\frac{m}{s^2}$

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**3** **Your friend says acceleration is speed divided by distance. Write the correct formula for acceleration in words.**

- **A** Speed divided by distance
- **B** Distance divided by time
- **C** Change in velocity divided by time
- **D** Change in time divided by velocity

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**4** A speedometer shows m/s, and a stopwatch shows seconds. What unit do we measure acceleration in?

- **A** $\frac{m}{s}$
- **B** $\frac{m}{s^2}$
- **C** $\frac{m^2}{s}$
- **D** $\frac{m}{s^3}$

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**5** A car accelerates at 2 m/s² from rest. How long does it take to reach 20 m/s?

- **A** 5 seconds
- **B** 10 seconds
- **C** 20 seconds
- **D** 40 seconds

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## A skateboarder travelling at 15 m/s brakes with an acceleration of −5 m/s² for 3 seconds. What is his final velocity?

A 0 m/s

B 5 m/s

C -5 m/s

D 30 m/s

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## A cyclist rounds a bend at a steady speed. Is she accelerating? Answer yes or no.

A Yes

B No

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**8** A sprinter speeds up out of the starting blocks. Is her acceleration in the same direction as her motion, or opposite to it?

- **A** Opposite to motion
- **B** Same direction as motion

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**9** A train brakes as it pulls into the station. Is its acceleration in the same direction as its motion, or opposite to it?

- **A** Opposite to motion
- **B** Same direction as motion

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## A car's acceleration is 4 m/s². By how much does its velocity change in 3 seconds?

A 3 m/s

B 4 m/s

C 12 m/s

D 7 m/s

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## ANSWER KEY

**1.** $5\frac{m}{s^2}$

**2.** $-2\frac{m}{s^2}$

**3.** Change in velocity divided by time

**4.** $\frac{m}{s^2}$

**5.** 10 seconds

**6.** 0 m/s

**7.** Yes

**8.** Same direction as motion

**9.** Opposite to motion

**10.** 12 m/s

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