Acceleration – GCSE Physics

CONTENTS:

1. Introduction:

- Acceleration is the rate at which an object's velocity changes over time.
- It is a vector quantity.
- It measures the motion of an object.

Real-life Scenario::

Car Speeding Up
or Slowing Down

Throwing a Ball

Elevator Moving
Up or Down

Merry-Go-Round

Skydiving

Plane Landing

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2. What is Acceleration??

- Acceleration is the rate of change of the Velocity of an object with respect to time.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Change in time}}$$

Types of Acceleration:

- **Uniform Acceleration** – Velocity changes at a constant rate .

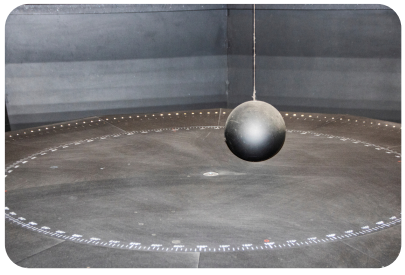
Examples:

A train slowing down uniformly

A rocket taking off

- **Non-Uniform Acceleration** – Velocity changes at a varying rate.

Examples:



A swinging pendulum

A parachutist falling

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3. Acceleration Formula:

Basic Acceleration Formula:

This formula defines Acceleration as the rate of change of velocity over time.

$$a = \frac{\Delta v}{\Delta t} = \frac{Final Velocity\,(v) - Initial Velocity\,(u)}{\Delta t}$$

Where:

- **a** = acceleration (m/s^2)
- **Δv** = change in velocity (v – u)
- **Δt**= time taken (s)

Example: A truck speeds up from 5 m/s to 25 m/s in 10 seconds. Find the acceleration.

Solution:

Given:

- **v =** 25m/s
- **u =** 5m/s
- **t =** 10s

Using the formula,

$$a = \frac{\Delta v}{\Delta t}$$

Putting the values,

$$a = \frac{25 - 5}{10} = \frac{20}{10} = 2$$

Acceleration is 2 m/s^2

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Kinematic Equation:

✨ Formula#1 ✨

- When Acceleration is constant, and time is not directly involved then this equation is used.
- It helps calculate Final Velocity, Initial Velocity, Acceleration, or Displacement

$$v^2 = u^2 + 2as$$

Where:

- **v** = final velocity (m/s)
- **u** = initial velocity (m/s)
- **a** = acceleration (m/s^2)
- **s** = displacement (m)

Example: A bike starts from rest and accelerates at 3 m/s^2over a distance of 50 meters. Find its final velocity.

Solution:

Given:

- **u =** 0 m/s
- **a =** 3 m/s^2
- **s =** 50m

Using the formula,

$$v^2 = u^2 + 2as$$

Putting the values,

$$v^2 = (0)^2 + 2(30)(50)$$

$$v^2 = 0 + 300 = 300$$

$$v = \sqrt{300} = 17.32$$

Final velocity is 17.32 m/s

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✨ Formula#2 ✨

This equation is used to calculate the Final Velocity of an object when Initial Velocity, Acceleration, and Time are known.

$$v = u + at$$

Where:

- **v** = final velocity (m/s)
- **u** = initial velocity (m/s)
- **a** = acceleration (m/s^2)
- **t** = time (s)

Example: A car starts from rest and accelerates at 4 m/s^2 for 5 seconds. Find the final velocity of a car.

Solution:

Given:

- **u =** 0 m/s
- **a =** 4 m/s^2
- **t =** 5s

Using the formula,

$$v = u + at$$

Putting the values,

$$v = 0 + (4 \times 5)$$

$$v = 20$$

Final Velocity is 20 m/s

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5. Can Acceleration be Positive or Negative?

Yes, acceleration can be both positive and negative, depending on an object whether it is speeding up or slowing down.

- **Positive Acceleration:**

When an object's velocity increases over time, then the acceleration is in the same direction as its velocity, and it consider as **Positive Acceleration.**

Example:
- Car speeding up
- Launching a Rocket into a Space
- A Plane Taking Off
- Ball Rolling Down a Hill

- **Negative Acceleration:**

When an object's velocity decreases over time, then the acceleration is in the opposite direction to its velocity, and it consider as **Negative Acceleration.**

Example:
- Car Braking to Stop
- Bicycle Stopping After Pedaling
- Throwing a Ball Upwards
- Parachute Opening During a Skydive

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5. What is Acceleration due to Gravity?

Without any forces acting on an object, when it falls freely under the influence of Earth's Gravity then the Acceleration is said as Acceleration due to Gravity.

Value of g on Earth:

$$g = 9.8 \text{ m/}s^2$$

6. FAQs

1. What is a negative acceleration called?

A negative acceleration is called deceleration. It means the object is slowing down.

2. What is the unit for acceleration?

Acceleration is measured in metres per second squared (m/s^2).

3. Is acceleration a vector or scalar?

Acceleration is a vector — it has both size and direction.

4. What is the value of acceleration due to gravity?

It is 9.8 m/s^2, often rounded to 10 m/s^2 in GCSE calculations.

5. What is the formula to calculate acceleration?

$$a = \frac{v - u}{t}$$

Use this when you know Initial Velocity, Final Velocity, and Time.