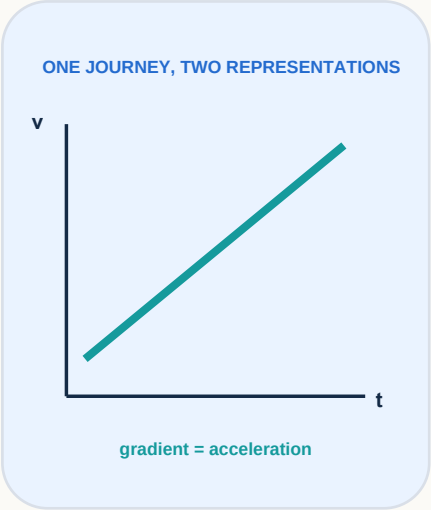
PEARSON EDEXCEL IAL PHYSICS | UNIT 1

LESSON 1.1.2

Kinematic Equations and Motion Graphs

Constant-acceleration equations and motion graphs describe the same journey from two different viewpoints.



THE FIVE SUVAT QUANTITIES

s	u	v	a	t
displacement	initial velocity	final velocity	acceleration	elapsed time
m	$m\ s^{-1}$	$m\ s^{-1}$	$m\ s^{-2}$	s

WHEN CAN SUVAT BE USED?

Use the four standard equations only for one-dimensional motion with constant acceleration throughout the chosen interval.

BY THE END, YOU SHOULD BE ABLE TO...

1. Select the equation that omits the unwanted quantity.
2. Use signs and SI units consistently in constant-acceleration calculations.
3. Read gradients and signed areas from displacement-, velocity-, and acceleration-time graphs.

CORE HABIT

Write s, u, v, a, t first. Mark the knowns, circle the unknown, and keep the positive direction visible.

1 The four kinematic equations

Each equation connects four of the five SUVAT quantities. Choose the one that leaves out the quantity you do not need.

Required condition: constant acceleration in one dimension

EQUATION 1

$$v = u + at$$

omits displacement, s

EQUATION 2

$$s = ut + \frac{1}{2}at^2$$

omits final velocity, v

EQUATION 3

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

omits time, t

EQUATION 4

$$s = \frac{1}{2}(u + v)t$$

omits acceleration, a

A RELIABLE SELECTION METHOD

1 **Choose** a positive direction.

2 **List** s, u, v, a and t with units.

3 **Match** knowns and the unknown.

4 **Select** the equation omitting the spare quantity.

WORKED EXAMPLE

A car has $u = 4\ m\ s^{-1}$, $a = 2\ m\ s^{-2}$ and $t = 6\ s$.

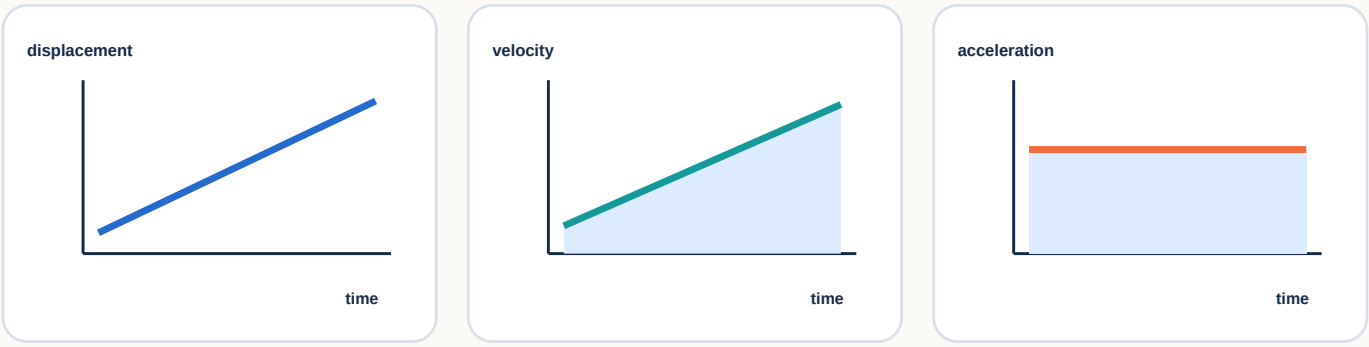
$$v = u + at = 4 + (2)(6) = 16\ m\ s^{-1}$$

$$s = ut + \frac{1}{2}at^2 = (4)(6) + \frac{1}{2}(2)(6^2) = 60\ m$$

2 Motion graphs tell the same story

Read the axis labels first. The height, gradient and signed area represent different physical quantities.

THREE GRAPH TYPES



DISPLACEMENT-TIME

gradient = velocity

VELOCITY-TIME

gradient = acceleration

ACCELERATION-TIME

area = change in velocity

Area under a velocity-time graph = signed displacement

GRAPH-EQUATION CROSS-CHECK

Velocity rises uniformly from 4 m/s to 16 m/s in 6 s.

$$a = \frac{16 - 4}{6} = 2\ \text{m s}^{-2}$$

$$\text{area} = \frac{1}{2}(4 + 16)(6) = 60\ \text{m}$$

The graph and SUVAT agree because both describe the same motion.

COMMON GRAPH TRAPS

SIGNED AREA

Below the time axis, velocity-time area is negative for displacement. Add magnitudes instead for total distance.

CURVED GRAPH

A curved velocity-time graph has changing acceleration, so one constant value of a cannot describe the whole interval.