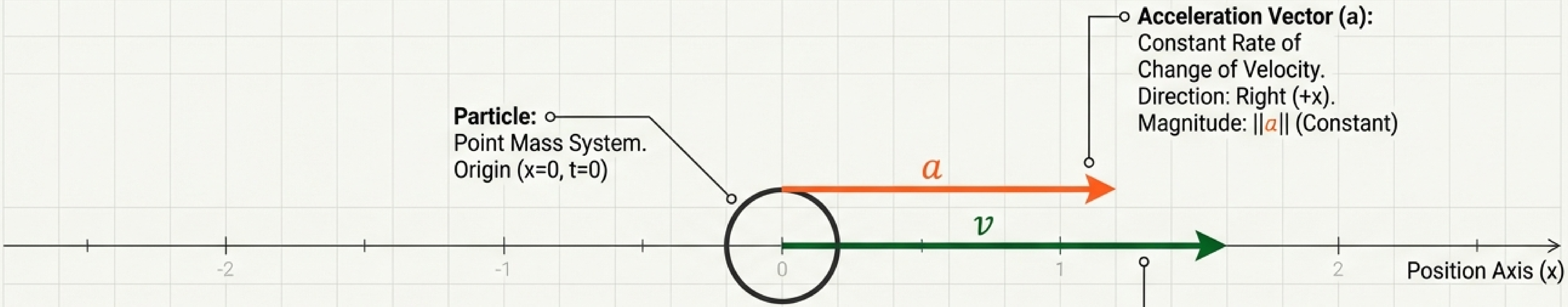
Constant Acceleration

The Technical Blueprint of Motion



VARIABLE	DEFINITION & SYMBOL	
Displacement	Change in Position. $s = x_{final} - x_{initial}$. Blueprint Blue (#005A9C)	s
Velocity	Rate of Change of Displacement. u (Initial), v (Final). Forest Green (#0B6623)	u, v
Acceleration	Rate of Change of Velocity. a (Constant), g (Gravity). Safety Orange (#FF5F1F)	a, g
Time	Duration or Instant. t. Slate Grey (#708090)	t

KINEMATIC EQUATIONS (CONSTANT a)

1. $v = u + at$	2. $s = ut + ½at^2$	3. $v^2 = u^2 + 2as$

The Kinematics Staircase

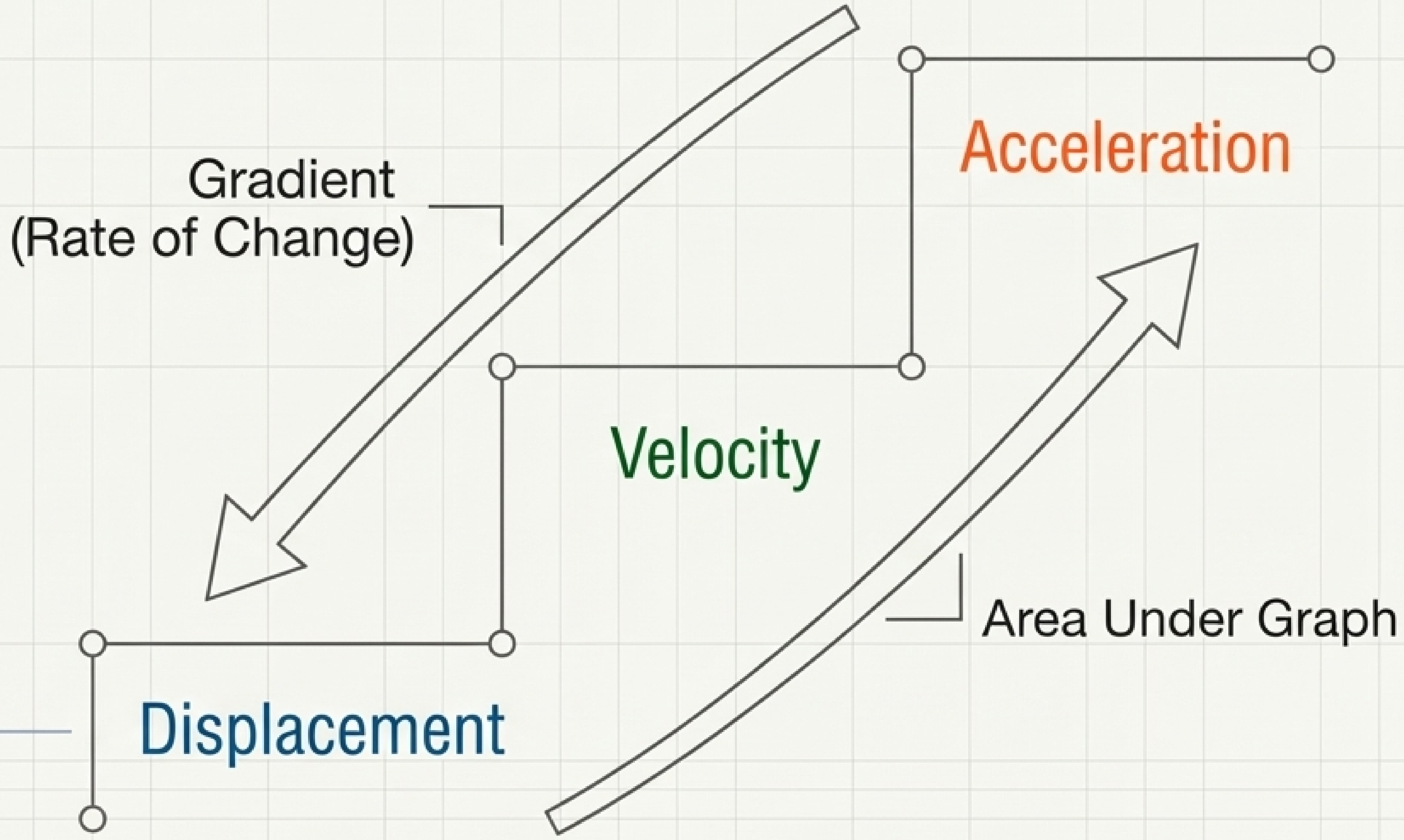
The Core Variables

s (Blueprint Blue):
Displacement [m]

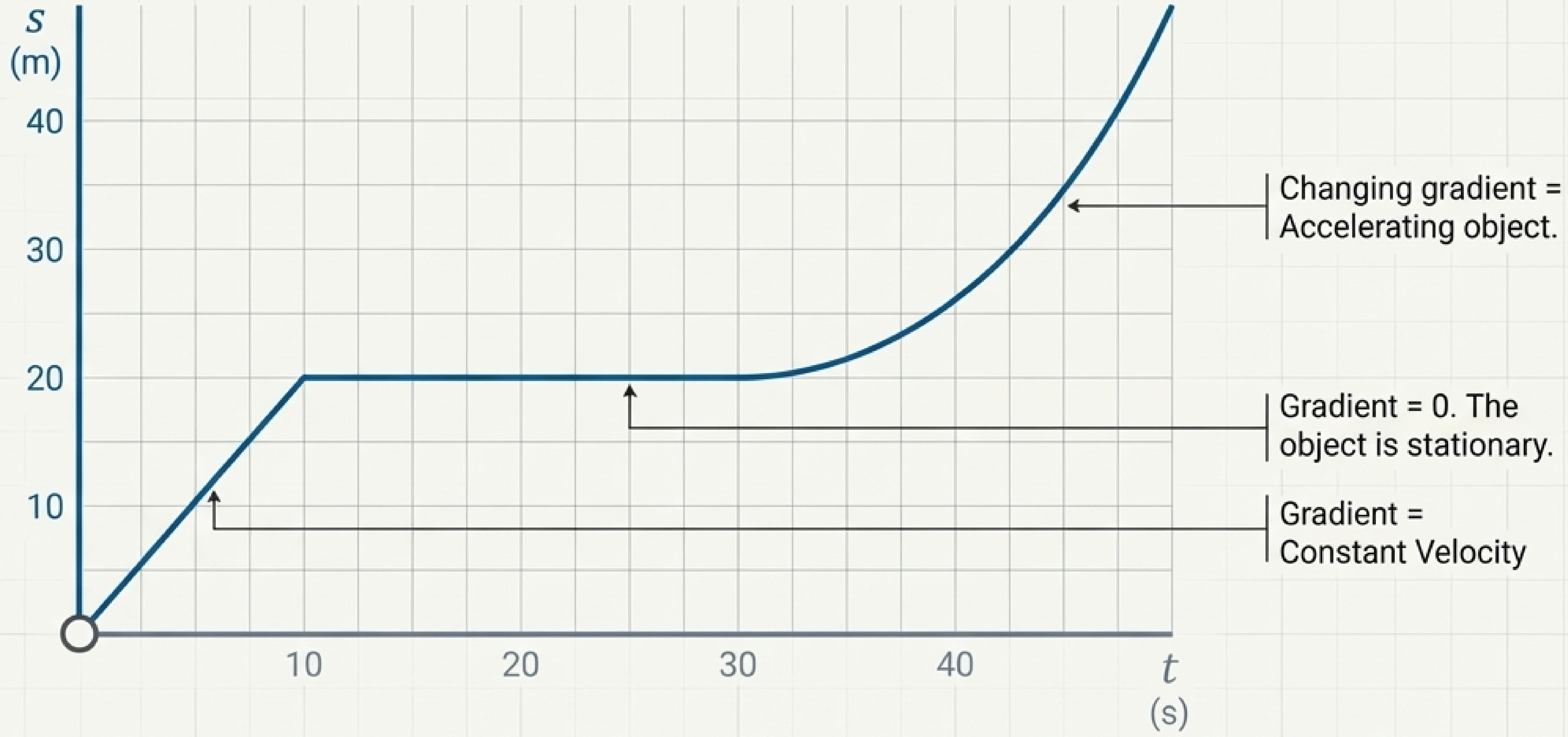
v (Forest Green):
Velocity [m s^{-1}]

a (Safety Orange):
Acceleration [m s^{-2}]

t (Slate Grey):
Time [s]



Displacement-Time Graphs

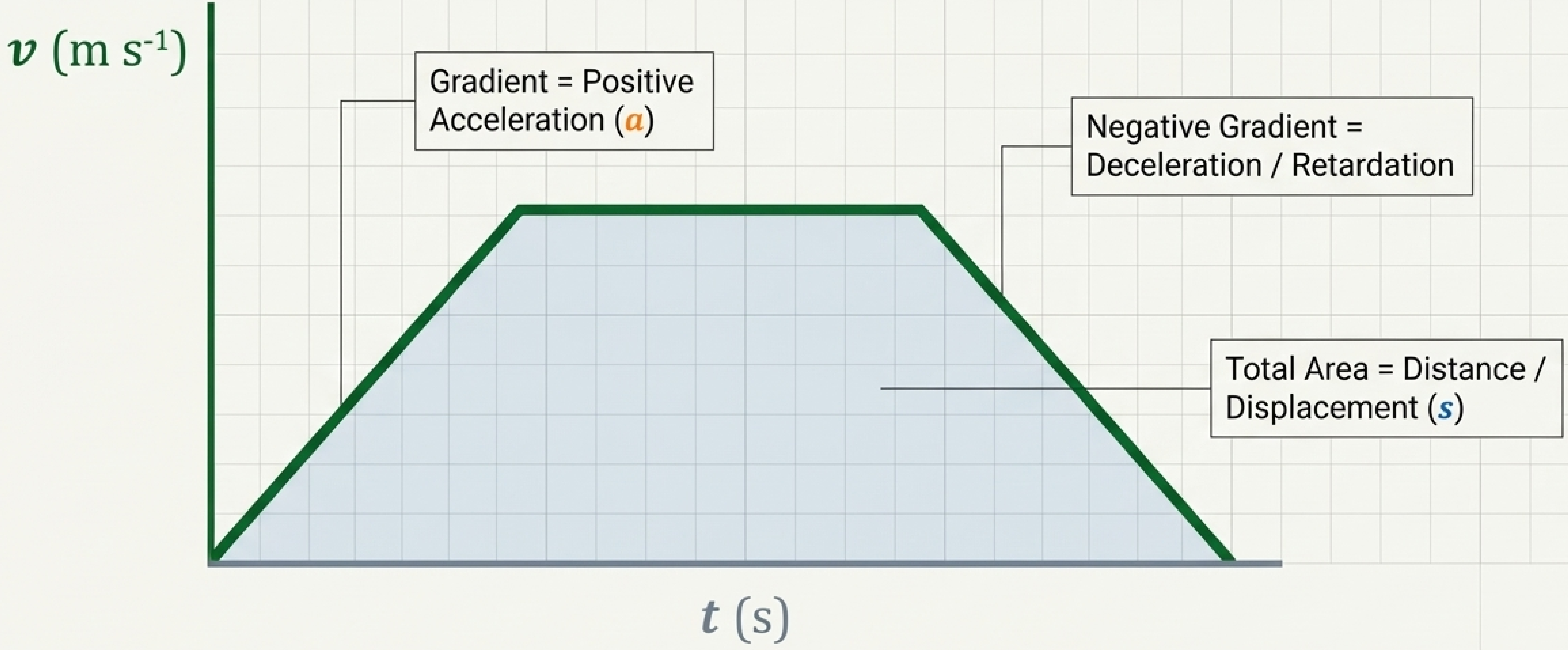


Key Averages

$$\text{Average Velocity} = \frac{\text{displacement from starting point}}{\text{time taken}}$$

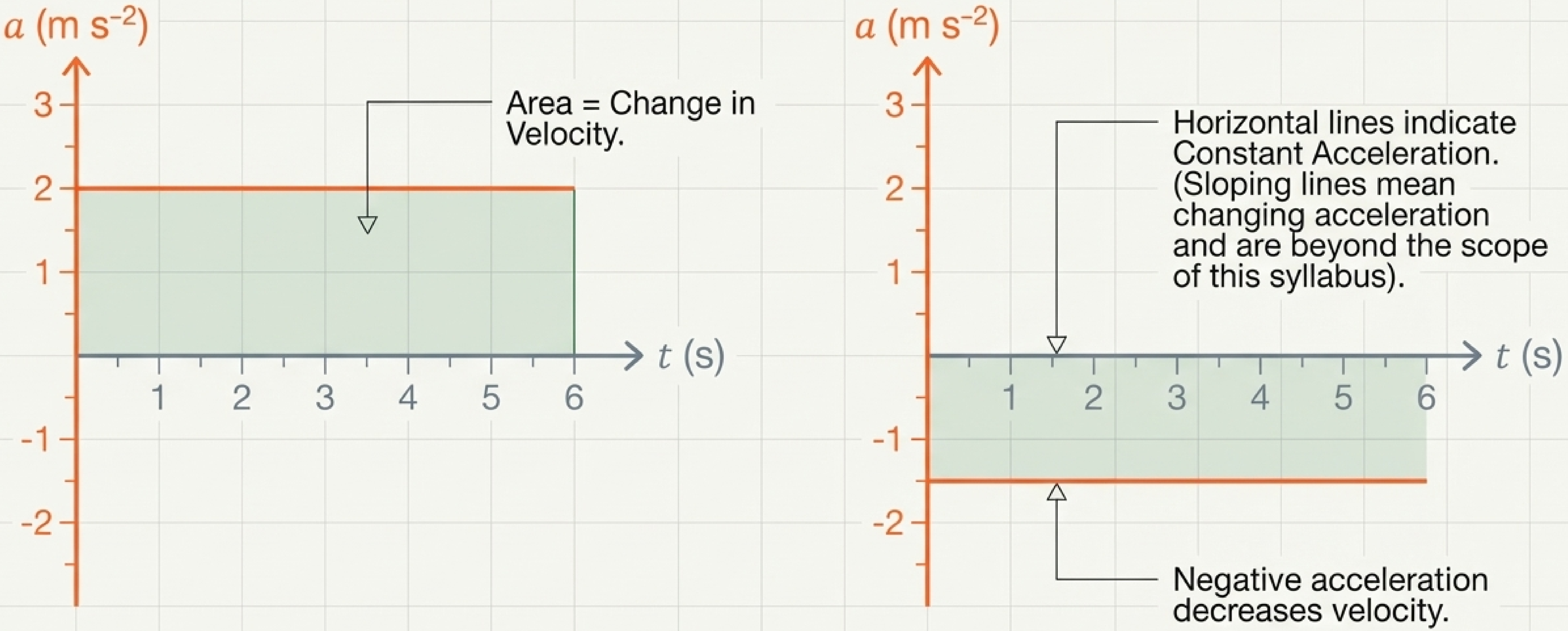
$$\text{Average Speed} = \frac{\text{total distance travelled}}{\text{time taken}}$$

Velocity-Time Graphs



For motion in a straight line with positive velocity, the area under the velocity-time graph up to a point t represents the displacement.

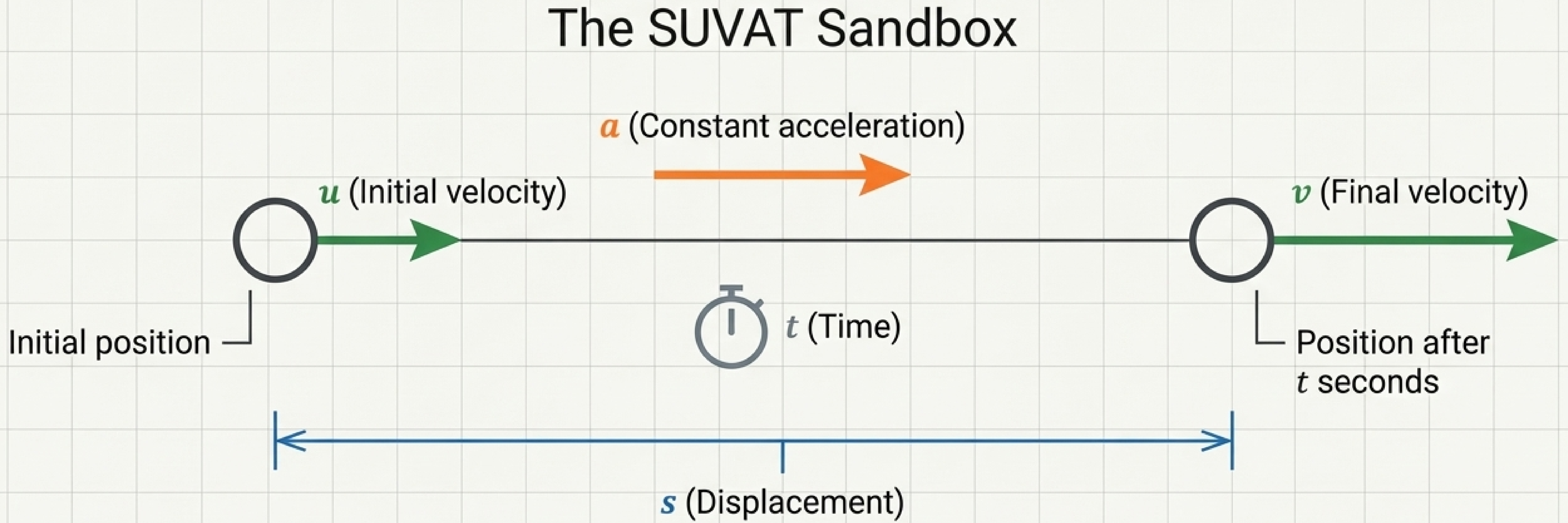
Acceleration-Time Graphs



The Motion Graph Rosetta Stone

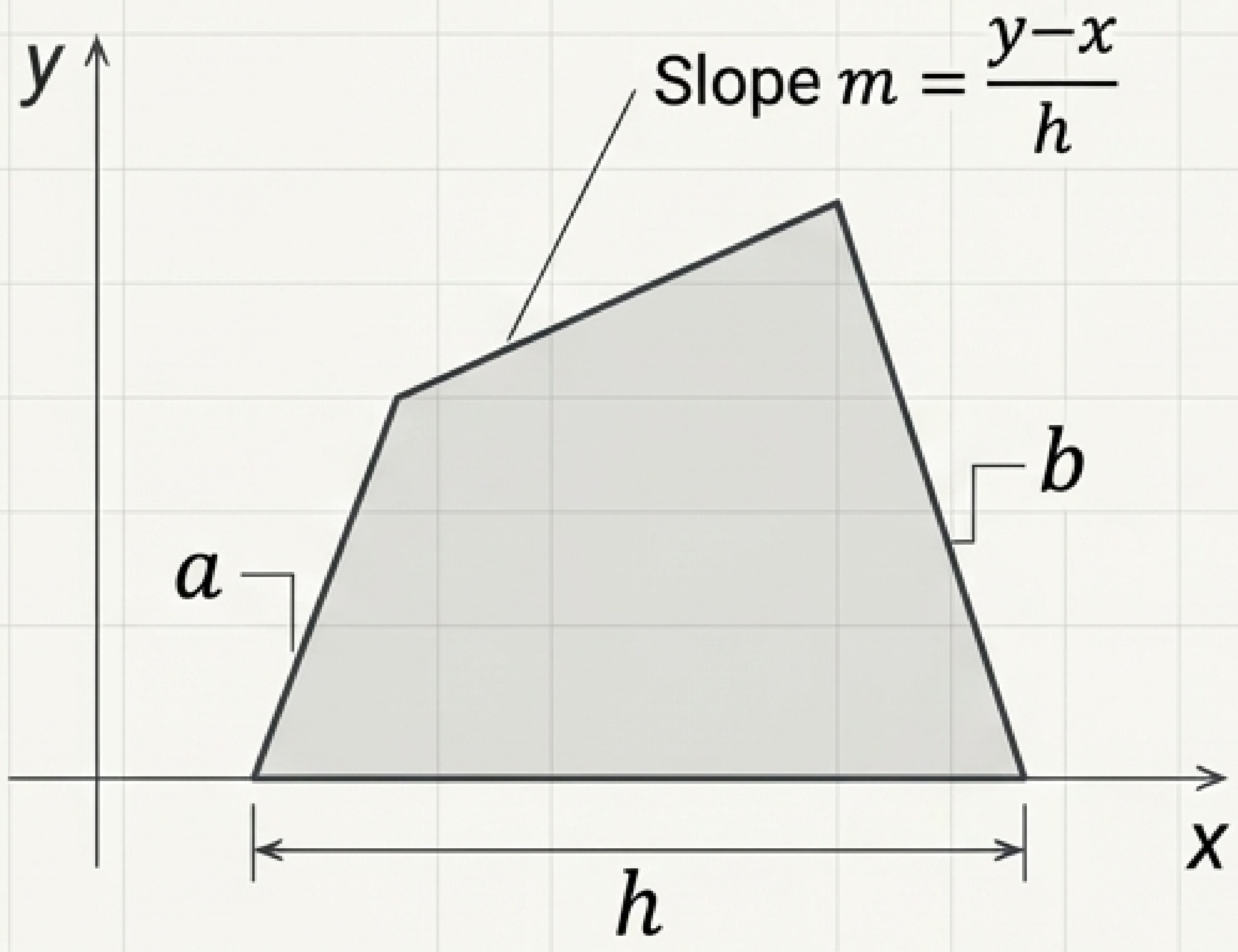
	Displacement-Time (#005A9C s - #708090 t)	Velocity-Time (#0B6623 v - #708090 t)	Acceleration-Time (#FF5F1F a - #708090 t)
Y-Axis Represents	Position	Speed and Direction	Rate of velocity change
Gradient Represents	Velocity (#0B6623 v)	Acceleration (#FF5F1F a)	Rate of acceleration change (Jerk)
Area Represents	N/A	Displacement (#005A9C s)	Change in Velocity (#0B6623 Δv)
Horizontal Line Means	Stationary	Constant Velocity (#0B6623 v)	Constant Acceleration (#FF5F1F a)

The Standard Model of Motion



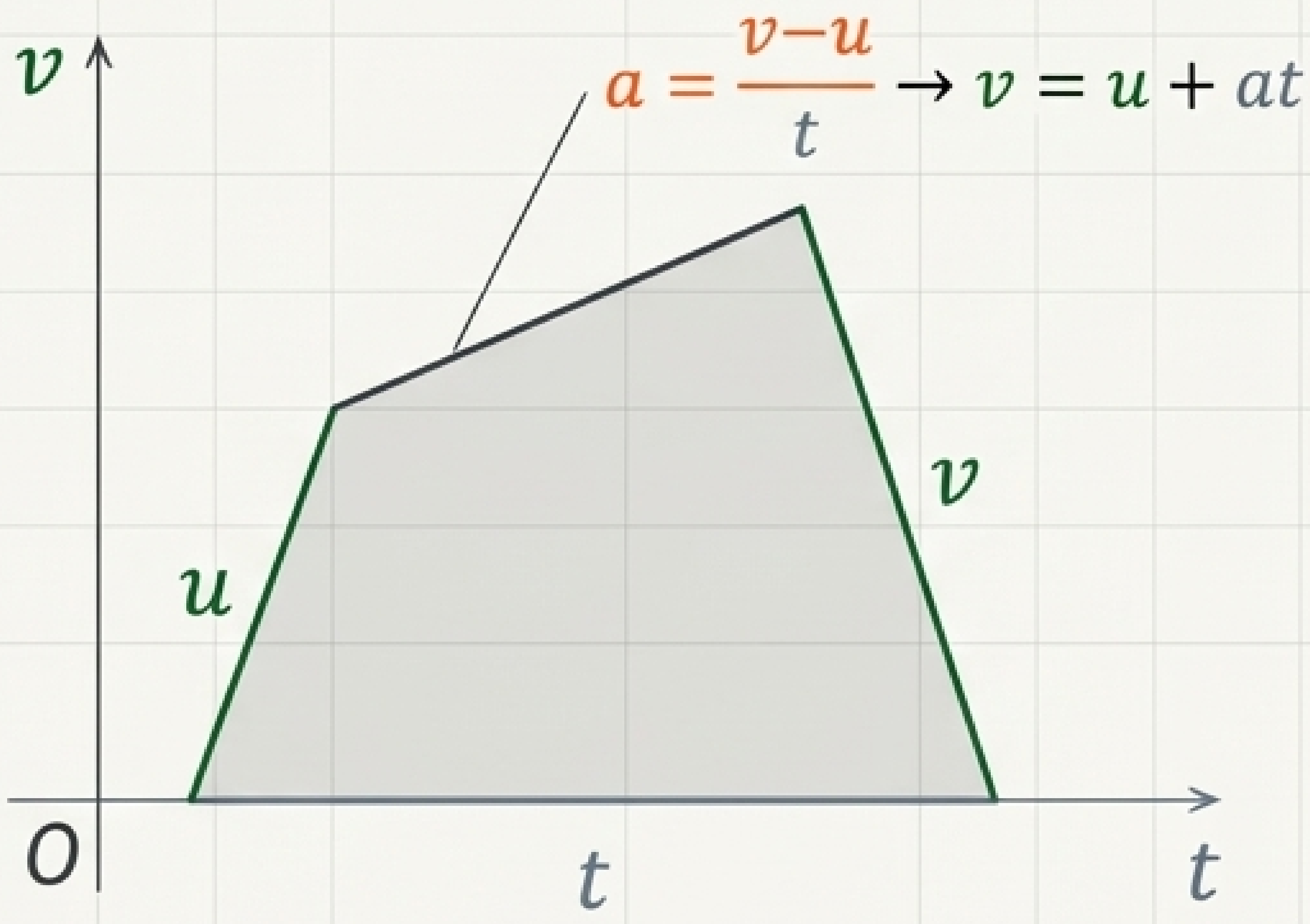
Geometry Synthesizes into Algebra

Pure Geometry



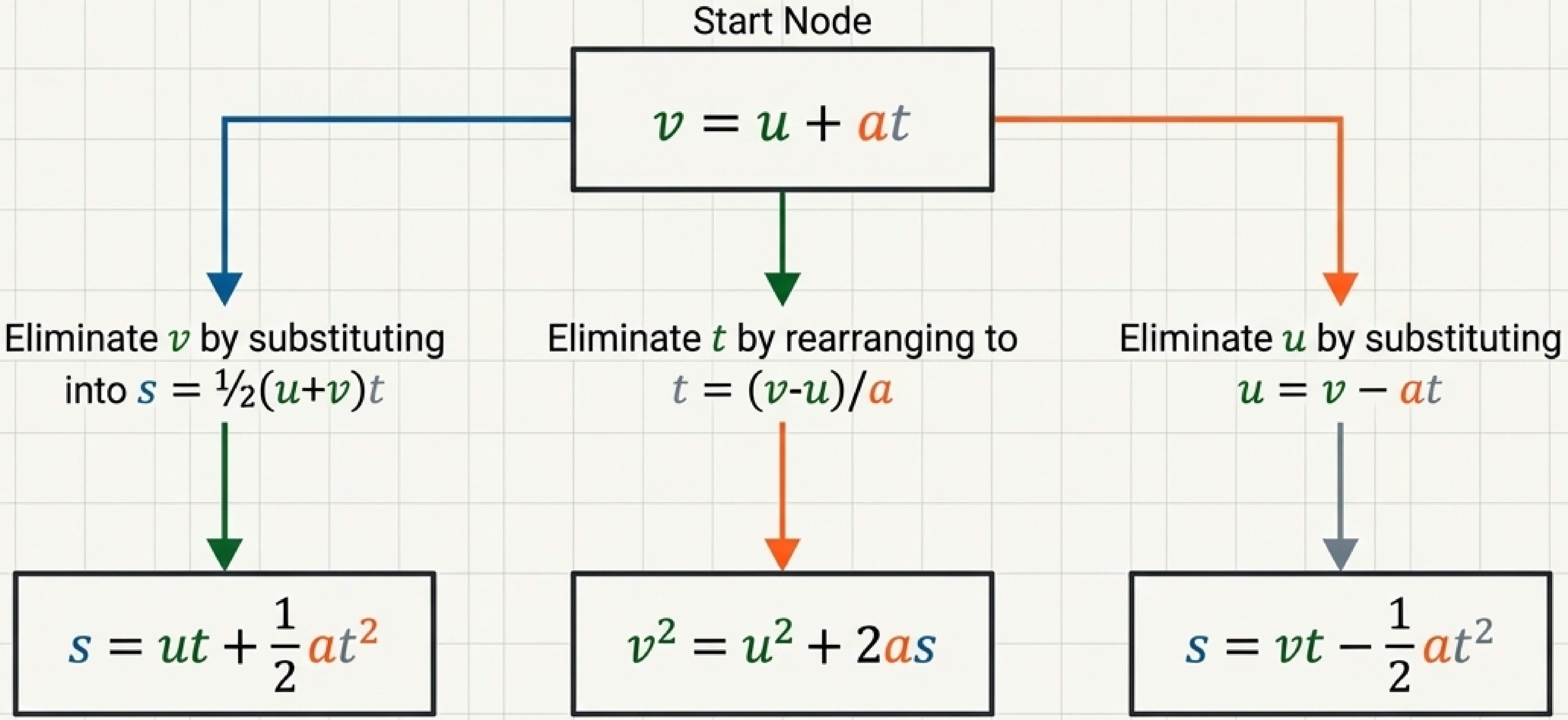
$$\text{Area} = \frac{1}{2}(a+b)h$$

Kinematics



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

Expanding the Toolkit: Formulae 2



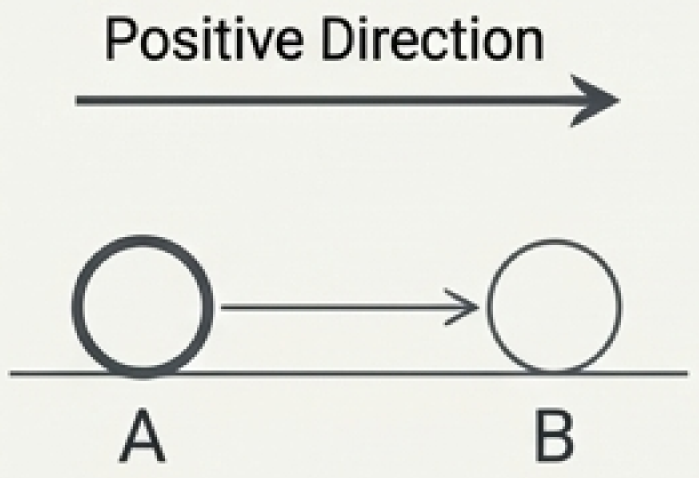
These five relationships are the universal ‘SUVAT’ formulae. They govern any particle moving in a straight line with constant acceleration.

The Diagnostic Decision Matrix

Missing Variable (The one you don't care about)	**Use This SUVAT Equation**
Missing s?	→ Use $v = u + at$
Missing v?	→ Use $s = ut + 1/2at^2$
Missing t?	→ Use $v^2 = u^2 + 2as$
Missing a?	→ Use $s = 1/2(u+v)t$
Missing u?	→ Use $s = vt - 1/2at^2$

Problem-Solving Masterclass

Step 1: Sketch & Orient



Clean technical sketch with a clean cacticular particle.

Step 2: List the Knowns

s	
u	
v	
a	
t	

Write values next to knowns.

Put a '?' next to the target.

Put an 'X' next to the irrelevant variable.

Write values next to knowns. Put a **'?'** next to the target. Put an **'X'** next to the irrelevant variable.

Step 3: Consult the Matrix

Missing Variable
Missing s?
Missing v?
Missing t? → $v^2 = u^2 + 2as$
Missing a?
Missing u?

Use the **'X'** variable to choose the correct formula from the Decision Matrix.

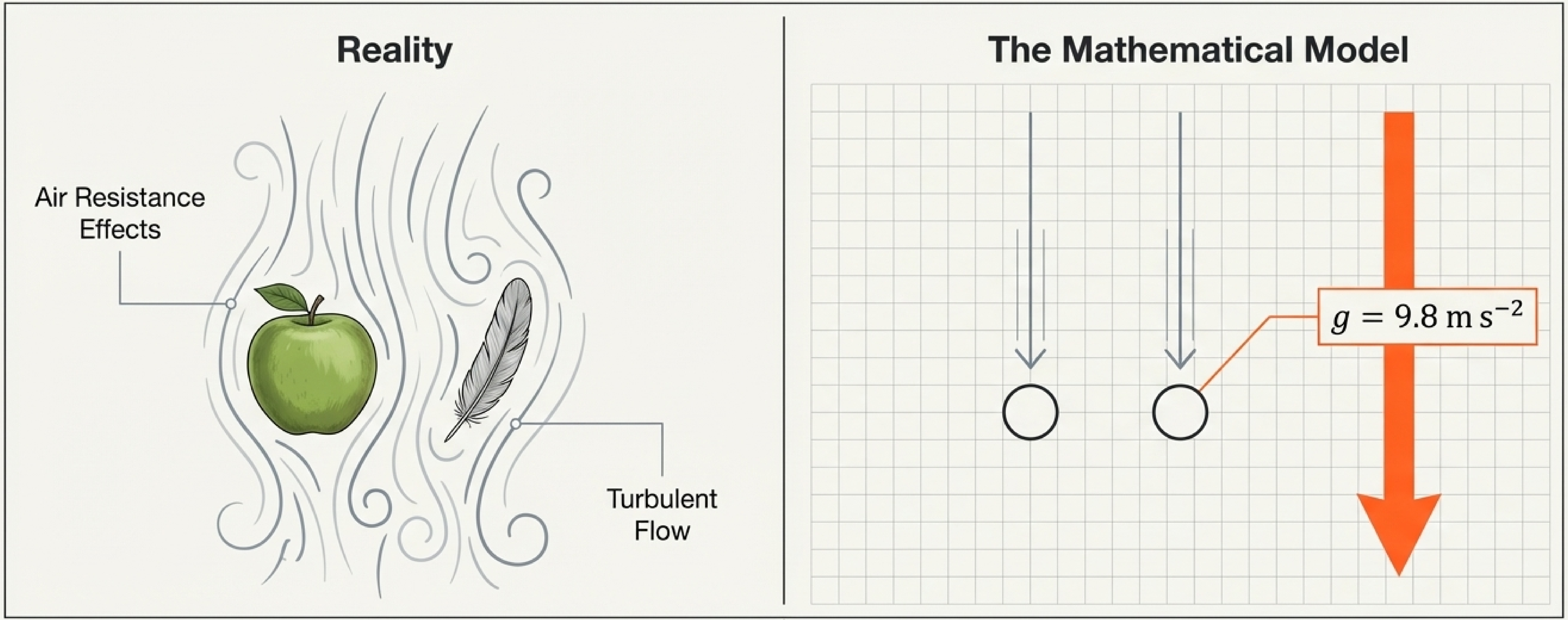
Step 4: Solve & Sanity Check

$$v^2 = 0^2 + 2(5)(10)$$

$$v = \pm 10 \text{ ms}^{-1}$$

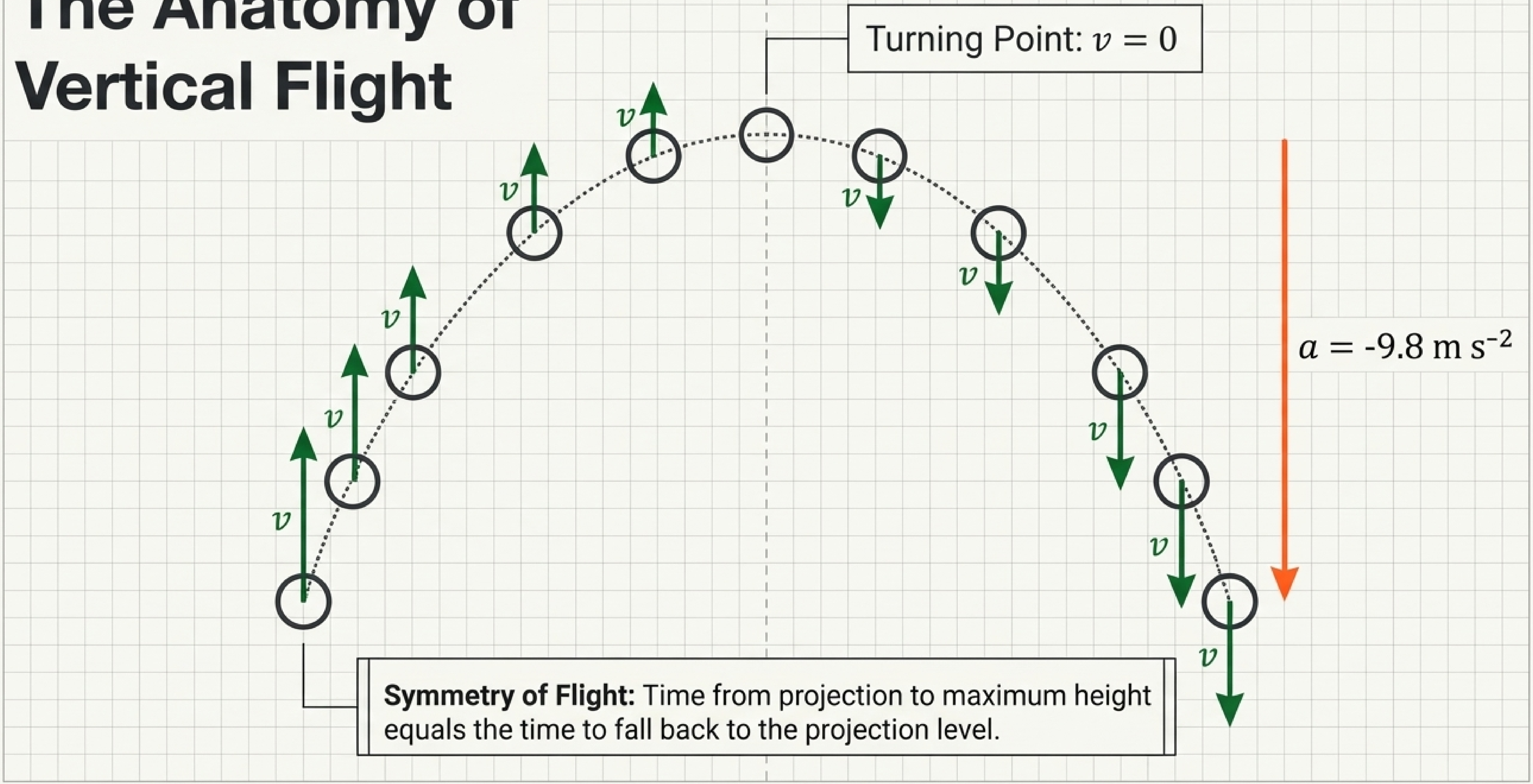
Substitute values, solve, and ensure the sign (+/-) makes physical sense.

Vertical Motion Under Gravity

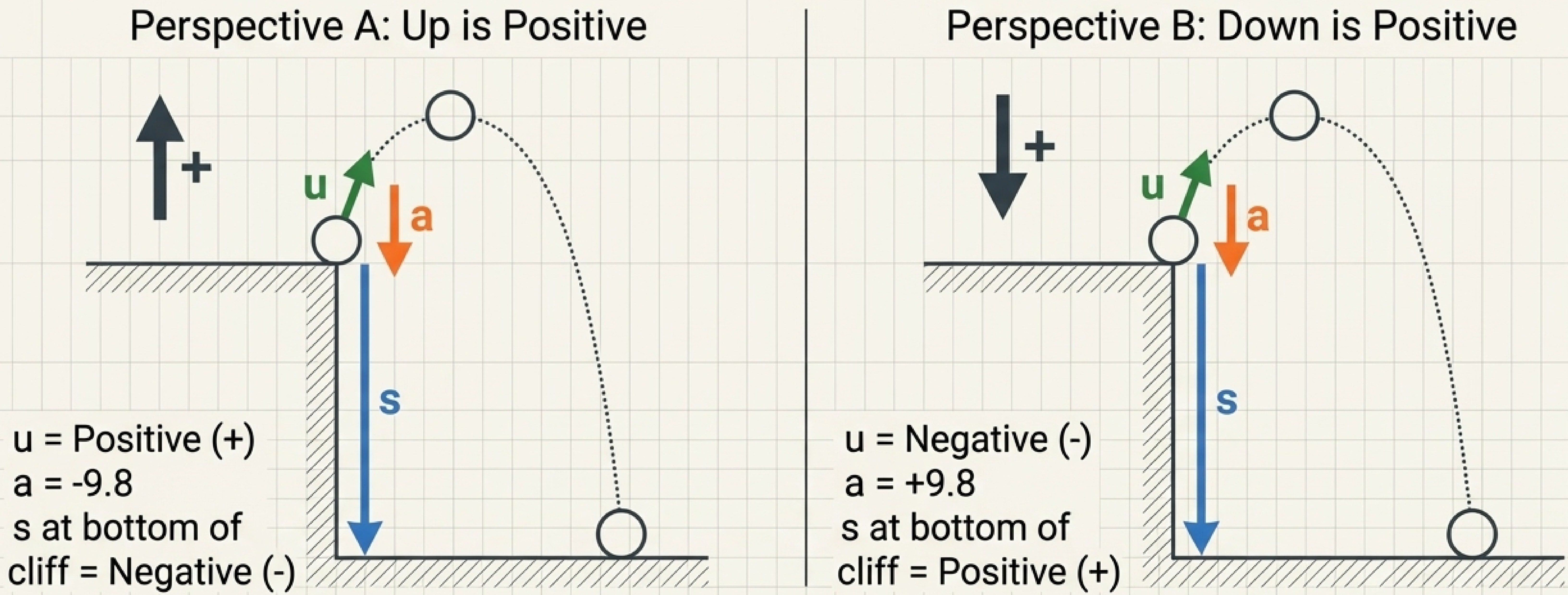


Modelling Assumptions		
Object is modeled as a dimension-less particle.	Air resistance is strictly ignored.	Acceleration is entirely uniform (9.8 m s^{-2}) regardless of mass.

The Anatomy of Vertical Flight



The Danger of Direction: Sign Conventions

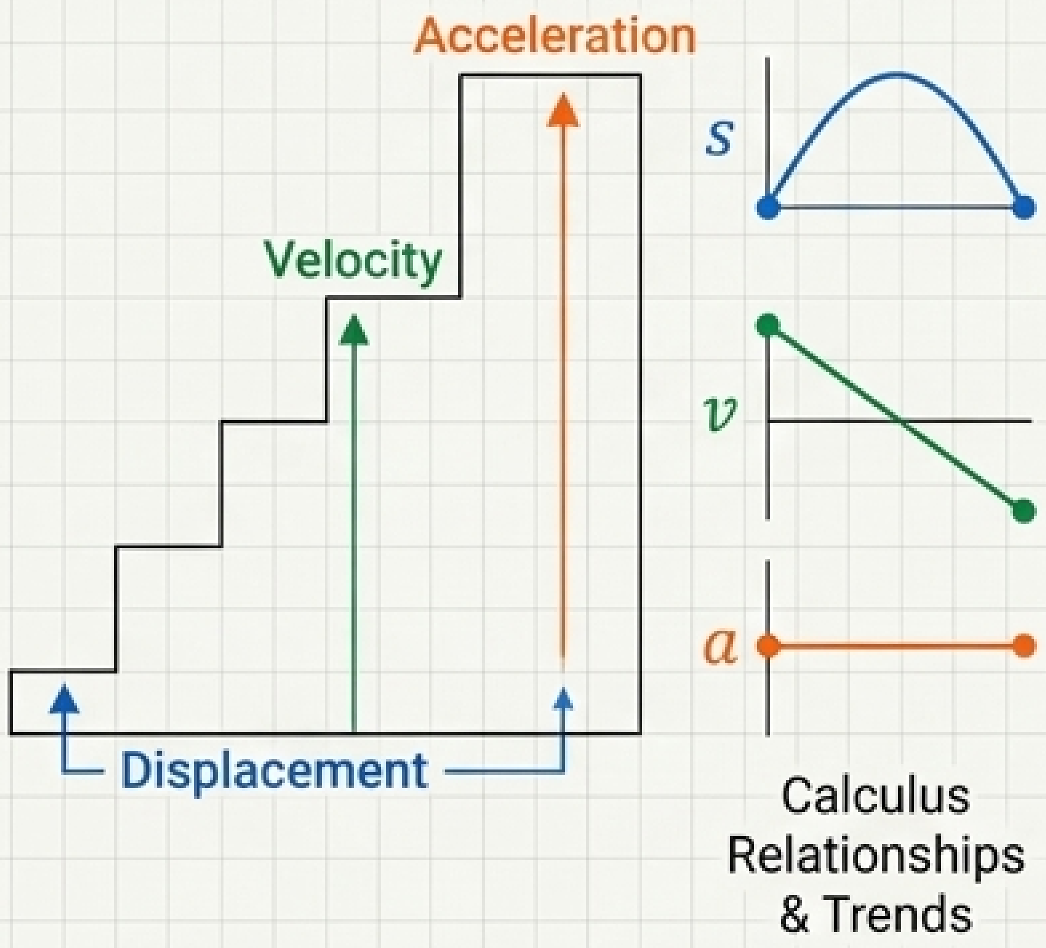


Core Rule Warning Box

Gravity always acts downwards. You must explicitly choose your positive direction before writing your SUVAT values. Both choices are correct, but mixing them is fatal.

The Blueprint Summary

The Staircase & Graphs



The SUVAT Matrix

Formula	Missing Variable
$v = u + at$	s
$s = ut + \frac{1}{2}at^2$	v
$s = \frac{1}{2}(u + v)t$	a
$v^2 = u^2 + 2as$	t
$s = vt - \frac{1}{2}at^2$	u

Gravity Rules