SUVAT Equations Worksheet

GCSE & A-Level Physics and Mechanics | With Fully Worked Answers

SUVAT Reference Sheet

Select the equation that contains your 3 known variables and 1 unknown. The missing variable column shows which quantity is absent from each formula.

#	Formula	Missing Variable
1	$v = u + at$	s (displacement)
2	$s = ut + \frac{1}{2}at^2$	v (final velocity)
3	$v^2 = u^2 + 2as$	t (time)
4	$s = \frac{1}{2}(u + v)t$	a (acceleration)
5	$s = vt - \frac{1}{2}at^2$	u (initial velocity)

Variable	Meaning	SI Unit
s	Displacement	metres (m)
u	Initial velocity	m/s
v	Final velocity	m/s
a	Acceleration	m/s²
t	Time	seconds (s)

Important: SUVAT equations apply only to constant acceleration in a straight line. For vertical motion under gravity, use a = 9.8 m/s² downward (or g = -9.8 m/s² when taking upward as positive).

GCSE Questions (5 Questions)

Each question requires one SUVAT equation and one unknown. Write the equation, substitute the known values, and state the answer with units.

Q1 A car starts from rest and accelerates at 4 m/s² for 6 seconds. Find the final velocity.

Q2 A ball rolls with an initial velocity of 8 m/s and decelerates at 2 m/s². Find the displacement after 3 seconds.

Q3 A cyclist accelerates from 3 m/s to 9 m/s over a distance of 18 m. Find the acceleration.

Q4 A train travels at 30 m/s and brakes with a deceleration of 5 m/s². Find the stopping distance (v = 0).

Q5 A stone is dropped from rest and falls for 4 seconds. Find the distance fallen. (g = 9.8 m/s²)

A-Level Questions (5 Questions)

These questions require multi-step working, sign conventions, or forming a quadratic equation. State your sign convention clearly before substituting values.

Q6 A ball is thrown vertically upward at 15 m/s from a point 2 m above the ground. Find the maximum height above the ground. ($g = 9.8$ m/s²)

Q7 A particle decelerates uniformly from 20 m/s to rest over 8 seconds. Find (a) the deceleration and (b) the total distance traveled.

Q8 A stone is projected vertically upward from the top of a 45 m cliff with initial velocity 10 m/s. Find the time for the stone to reach the base of the cliff. ($g = 9.8$ m/s²)

Q9 A particle moves with initial velocity 5 m/s under constant acceleration. It covers 18 m during the 3rd second of motion. Find the acceleration. Use the nth-second formula: $s_n = u + a(n - \frac{1}{2})$

Q10 Particle A leaves a fixed point at 6 m/s with zero acceleration. Particle B leaves the same point 4 seconds later with initial velocity 2 m/s and acceleration 2 m/s². Find the time after A departs when B catches A.

GCSE Worked Answers

Q1 Answer: Final Velocity

Known: $u = 0$, $a = 4\ m/s^2$, $t = 6\ s$ Unknown: v Missing variable: s

Equation: $v = u + at$

$v = 0 + (4)(6) = 24\ m/s$

Q2 Answer: Displacement With Deceleration

Known: $u = 8\ m/s$, $a = -2\ m/s^2$, $t = 3\ s$ Unknown: s Missing: v

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

$s = (8)(3) + \frac{1}{2}(-2)(3^2) = 24 - 9 = 15\ m$

Q3 Answer: Acceleration From Speed and Distance

Known: $u = 3\ m/s$, $v = 9\ m/s$, $s = 18\ m$ Unknown: a Missing: t

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

$81 = 9 + 2a(18) \rightarrow 72 = 36a \rightarrow a = 2\ m/s^2$

Q4 Answer: Stopping Distance

Known: $u = 30\ m/s$, $v = 0$, $a = -5\ m/s^2$ Unknown: s Missing: t

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

$0 = 900 + 2(-5)s \rightarrow 10s = 900 \rightarrow s = 90\ m$

Q5 Answer: Free Fall Distance

Known: $u = 0$, $a = 9.8\ m/s^2$, $t = 4\ s$ Unknown: s Missing: v

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

$s = 0 + \frac{1}{2}(9.8)(4^2) = \frac{1}{2}(9.8)(16) = 78.4\ m$

A-Level Worked Answers

Q6 Answer: Maximum Height

Sign convention: upward = positive, so $a = -9.8\ m/s^2$.

At maximum height $v = 0$. Known: $u = 15\ m/s$, $v = 0$, $a = -9.8\ m/s^2$.

Equation: $v^2 = u^2 + 2as \rightarrow 0 = 225 - 19.6s \rightarrow s = 225 \div 19.6 = 11.48$ m above launch.

Height above ground = 2 + 11.48 = 13.5 m (3 s.f.)

Q7 Answer: Deceleration and Distance

(a) Known: $u = 20\ m/s$, $v = 0$, $t = 8$ s. Use $v = u + at$:

$0 = 20 + 8a \rightarrow a = -2.5\ m/s^2$

(b) Use $s = \frac{1}{2}(u + v)t = \frac{1}{2}(20 + 0)(8) = 80$ m

Q8 Answer: Time to Reach Ground From Cliff

Sign convention: upward = positive. The stone lands 45 m below launch, so $s = -45$ m.

Use $s = ut + \frac{1}{2}at^2$: $-45 = 10t - 4.9t^2 \rightarrow 4.9t^2 - 10t - 45 = 0$

Quadratic formula: $t = (10 \pm \sqrt{(100 + 882)}) \div 9.8 = (10 \pm 31.34) \div 9.8$

Taking the positive root: $t = 41.34 \div 9.8 = 4.22$ s (3 s.f.)

Q9 Answer: Acceleration Using the nth-Second Formula

nth-second formula: $s_n = u + a(n - \frac{1}{2})$. Substitute $n = 3$, $s_n = 18$, $u = 5$:

$18 = 5 + a(3 - 0.5) = 5 + 2.5a \rightarrow 13 = 2.5a \rightarrow a = 5.2\ m/s^2$

Q10 Answer: When Particle B Catches Particle A

Let t = time (seconds) after A departs. B has been traveling for $(t - 4)$ seconds.

Distance A: $s_A = 6t$

Distance B: $s_B = 2(t - 4) + \frac{1}{2}(2)(t - 4)^2$

Set $s_A = s_B$: $6t = 2(t - 4) + (t - 4)^2 \rightarrow t^2 - 12t + 8 = 0$

$t = (12 \pm \sqrt{(144 - 32)}) \div 2 = (12 \pm 10.58) \div 2$

Valid root: $t = 11.29$ s. B catches A approximately 11.3 s after A departs.

SUVAT equations apply only when acceleration is constant. Always state a sign convention before substituting. For variable acceleration, use calculus-based methods.