



eClassroom

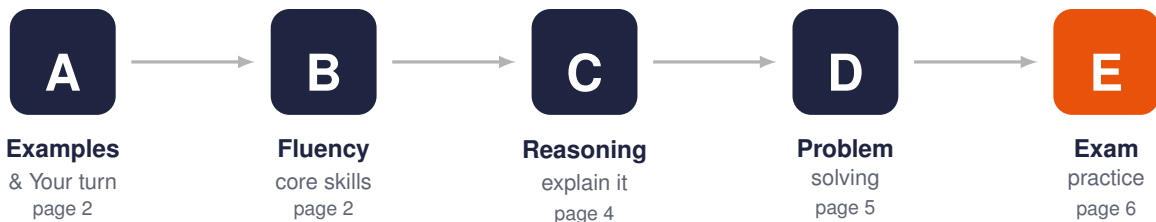
A-LEVEL MATHEMATICS • MECHANICS 1

Constant Acceleration

Worked Solutions

Pearson Edexcel International A Level (WME01) & A Level (9MA0) • Calculator and statistical tables allowed: take $g = 9.8 \text{ m s}^{-2}$ and give answers to 2 or 3 s.f.

Full worked solutions for the free Constant Acceleration worksheet, A-Level and International A-Level Maths



Tap a section to jump straight to it

Full worked solutions for every question on the Mechanics 1 Constant Acceleration worksheet, in the same order and with the same question numbers.

How to mark your work. Tick each step you got right, not just the final answer. At A-level most marks are for method, so a wrong final answer can still earn most of the marks. If you lost marks, find the *first* line where your working is different from ours. That is the thing to fix.

In Section E: **M** = method mark, **dM** = method mark that depends on the previous M mark, **A** = accuracy mark (needs the M mark before it), **B** = independent mark.

Question sheet

Exam questions by topic

Mechanics 1 exam questions

More worksheets



Join students already acing their exams.

Book your FREE lesson at www.eclassroom.org.uk

A**Your turn answers**

Compare each line of your working with the solution.

CORE

A1 $v = 12 - 6t$: 6 ms^{-1} ; $s = 48 - 12t$: 36 m

A2 $0 = 20^2 - 2(2.5)s$: 80 m

A3 $25 + 300 + 40t$: 365 m ; $\frac{10}{8}$: 1.25 ms^{-2}

STRETCH

A4 $0 = 19.6^2 - 19.6s$: 19.6 m ; $0 = 19.6 - 9.8t$: 2 s

A5 $-29.4 = 9.8t - 4.9t^2$, so $t^2 - 2t - 6 = 0$: $t = 1 + \sqrt{7} = 3.65 \text{ s}$

A6 Stage 1: $v = 12$, $s = 48$; stage 2: $\frac{144}{4} = 36$: 84 m

A7 $1.5t^2 = 9t$: $6 \text{ s}, 54 \text{ m from } O$

B**Fluency solutions**

One mark for each correct part. The notes in *italics* explain why each sequence was chosen.

CORE

B1 (a) $8 + 6t$: 14 ms^{-1} (b) $96 + 36t$: 132 m (c) $\frac{12}{0.5}$: 24 s (d) $\frac{400 - 64}{1}$: 336 m

Choose the formula that leaves out the quantity you do not know.

B2 (a) $\frac{30}{1.2}$: 25 s (b) $\frac{900}{2.4}$: 375 m (c) $\sqrt{900 - 600}$: 17.3 ms^{-1}

(d) $250 = 30t - 0.6t^2$, smaller root: 10.6 s

The larger root (about 39 s) is after the train has stopped, so reject it.



B3 (a) $\frac{20}{10}$: 2ms^{-2} (b) $\frac{20}{10}$: 2ms^{-2} (c) $100 + 600 + 100$: 800 m (d) $\frac{800}{50}$: 16ms^{-1}

Gradient gives acceleration; area gives distance.

B4 (a) $\frac{441}{19.6}$: 22.5 m (b) $\frac{21}{9.8}$: 2.14 s (c) 4.29 s (d) $\sqrt{441 - 294}$: 12.1ms^{-1}

Up is positive, so $a = -9.8$

CORE

B5 (a) $\frac{1200}{600}$: 2ms^{-1} (b) 15 minutes (c) $\frac{-1200}{900}$: -1.33ms^{-1}

The gradient of a displacement-time graph is the velocity; a negative gradient means she is walking back.

B6 (a) $\frac{54000}{3600}$: 15ms^{-1} (b) $\frac{225}{90}$: 2.5ms^{-2} (c) $\frac{15}{2.5}$: 6 s (d) $\frac{1}{2}(2.5)(1)^2$: 1.25 m

The last second, read backwards, starts from rest.

STRETCH

B7 (a) $\frac{49}{19.6}$: 2.5 m (b) $-40 = 7t - 4.9t^2$: 3.66 s (c) $\sqrt{49 + 784}$: 28.9ms^{-1} (d) $\frac{14}{9.8}$: 1.43 s

The sea is at $s = -40$ from the start.

B8 (a) $\frac{1}{2}(20)V = 150$: $V = 15$ (b) $\frac{15}{8}$: 1.88ms^{-2} (c) $\frac{15}{12}$: 1.25ms^{-2} (d) $\frac{150}{20}$: 7.5ms^{-1}

The area of the triangle uses the whole 20 s.

B9 (a) $s_A = t^2$, $s_B = 15t - 0.5t^2$ (b) $1.5t^2 = 15t$: $t = 10$ (c) 100 m (d) 20ms^{-1} and 5ms^{-1}

B is still moving at $t = 10$ (it would stop at $t = 15$), so the model holds.

B10 (a) $14.7 = 19.6t - 4.9t^2$, $t^2 - 4t + 3 = 0$: $1\text{ s and } 3\text{ s}$ (b) 2 s (c) 19.6 m (d) 9.8ms^{-1}

Both roots matter here: one on the way up, one on the way down.



C

Reasoning solutions

Your wording can be different. Check that your reason makes the same point.

CORE

C1 With up positive, $a = -9.8$: $s = 9.8t - 4.9t^2$

C2 72 km h^{-1} must be converted to 20 m s^{-1} first: $\frac{20}{8} = 2.5 \text{ m s}^{-2}$

C3 The initial speed is 5 m s^{-1} , so the graph must **start on the speed axis at 5**, rise in a straight line to V , then fall in a straight line to the time axis.

C4 V is a speed, so it must be positive: **reject $-\frac{20}{7}$ and give $V = 17$ only**

STRETCH

C5 No time passes in a vertical line. The speed falls to 0 at the top and then rises: **a V shape with its vertex on the time axis**, the second line longer than the first.

C6 The part leaves the rocket with the rocket's velocity: **$u = 5 \text{ m s}^{-1}$ upwards**, not 0

C7 Distance is the total path; displacement is the change in position: **distance 12 m, displacement 0 m**

C8 (a) The graph is a trapezium of parallel sides u and v and width t : $s = \frac{1}{2}(u+v)t$

(b) $t = \frac{v-u}{a}$, so $s = \frac{(u+v)(v-u)}{2a} = \frac{v^2 - u^2}{2a}$: **$v^2 = u^2 + 2as$**



D**Problem solving solutions**

There is often more than one correct method. Any complete, correct method scores full marks.

CORE

D1 (a) $-25 = 3U - 4.9(9)$, so $3U = 19.1$

$U = 6.37$

(b) $v = 6.37 - 29.4 \approx -23.0$: 23.0 ms^{-1}

D2 (a) $T_1 = \frac{200}{4+V}$, $T_2 = \frac{240}{V}$; $\frac{200}{4+V} + \frac{240}{V} = 25$ gives $5V^2 - 68V - 192 = 0$

$(5V + 12)(V - 16) = 0$: $V = 16$ (reject $-\frac{12}{5}$)

(b) $\frac{16}{15}$: 1.07 ms^{-2}

D3 (a) Area $= \frac{1}{2}(6)V + 24V = 27V = 216$: $V = 8$

(b) $\frac{8}{6}$: 1.33 ms^{-2}

D4 $12.6t - 4.9t^2 = 9.8(t - 1) - 4.9(t - 1)^2$, so $12.6t = 19.6t - 14.7$: $t = 2.1 \text{ s}$

$12.6(2.1) - 4.9(2.1)^2$: 4.85 m

STRETCH

D5 (a) $v = 9.8(4)$: 39.2 ms^{-1} ; $\frac{1}{2}(9.8)(16)$: 78.4 m

(b) Stage 2: $t = \frac{34.2}{3.5} \approx 9.77$, $s = \frac{39.2^2 - 25}{7} \approx 215.9$; stage 3: $\frac{500 - 78.4 - 215.9}{5} \approx 41.1$

$4 + 9.77 + 41.1$: 54.9 s

D6 Q : from $(4, 0)$ up to $(10, 9)$, then flat at 9; it covers 27 m by $t = 10$

$6t = 27 + 9(t - 10)$, so $3t = 63$: $t = 21 \text{ s}$, 126 m from O

D7 (a) The sandbag starts with $u = 4.9$ upwards: $-58.8 = 4.9t - 4.9t^2$, $t^2 - t - 12 = 0$: 4 s

(b) $4.9 - 39.2 = -34.3$: 34.3 ms^{-1}

(c) $58.8 + 4(4.9)$: 78.4 m



D8 (a) $120 = 8u + 32a$ and $240 = 14u + 98a$

$u = 15 - 4a$, so $240 = 210 + 42a$: $a = 0.714 \text{ ms}^{-2}$, $u = 12.1 \text{ ms}^{-1}$

(b) $\frac{85}{7} + 14\left(\frac{5}{7}\right)$: 22.1 ms^{-1}

E

Exam practice solutions

Mark-scheme notes are shown on the right of each line.

CORE

Exam questions for everyone

- E1 (a) A trapezium from the origin: up to V at 40, flat to 240, down to 0 at 300 B1 B1
- (b) $300 - 40 - 60$: $T = 200$ B1
- (c) $\frac{1}{2}(40)V + 200V + \frac{1}{2}(60)V = 6000$ M1 A1
- $250V = 6000$: $V = 24$ A1
- (d) $\frac{24}{40}$: 0.6 ms^{-2} B1
- (e) 480 m in the first 40 s; $480 + 24(t - 40) = 3000$ M1
- $t = 145 \text{ s}$ A1
- (f) $\frac{6000}{300}$: 20 ms^{-1} B1
-
- E2 (a) $0 = 14^2 - 19.6s$, so 10 m above A M1
- $2.1 + 10$: 12.1 m A1
- (b) $-2.1 = 14t - 4.9t^2$ M1 A1
- $7t^2 - 20t - 3 = 0$, $(7t + 1)(t - 3) = 0$: $t = 3$ A1*
- (c) $14 - 9.8(3) = -15.4$ M1
- 15.4 ms^{-1} A1
- (d) One straight line from (0, 14) down to (3, -15.4), crossing the time axis at 1.43 B1 B1
- (e) $7.7 = 14t - 4.9t^2$, $7t^2 - 20t + 11 = 0$; time between roots = $\frac{\sqrt{92}}{7}$ M1
- 1.37 s A1



STRETCH

- E3** (a) $\frac{20}{0.8} = 25$; $\frac{400}{1.6} = 250$ M1
- $t = 25, 250 \text{ m}$ A1
- (b) $\frac{18}{1.2} = 15 \text{ s}$ after starting; $\frac{18^2}{2.4} = 135$ M1
- $t = 20, 135 \text{ m}$ A1
- (c) P at $t = 20$: $20(20) - 0.4(20)^2 = 240$ M1
- $240 > 135$, so Q has not caught P A1
- (d) At $t = 25$, Q is at $135 + 18(5) = 225 < 250$, so P has already stopped M1 A1
- $135 + 18(t - 20) = 250$ M1
- $t = 26.4 \text{ s}$ A1
- (e) P : straight line from $(0, 20)$ to $(25, 0)$, then along the axis; Q : from $(5, 0)$ up to $(20, 18)$, then flat B1 B1 B1

