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# 9.5 - Vertical motion under gravity

If you need help on this chapter
[A-Level Maths | Mechanics Year 1 | 9.5 - Vertical motion under gravity Walkthrough | Edexcel]

**Q1a)**

A→B

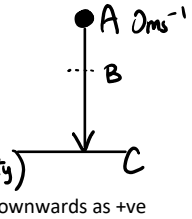
s

u = 0

v

a = 9.8 (+ve ∵ accel due to gravity)

t = 1



Take downwards as +ve

$v = u + at$

$v = 0 + 9.8(1)$

$v = 9.8 ms^{-1}$

**Q1b)** $s = ut + \frac{1}{2}at^2$

$s = 0 + \frac{1}{2}(9.8)(1)^2$

$s = 4.9m$

**Q1c)** A→C

s = 8

u = 0

v

a = 9.8

t

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

$v = \sqrt{0 + 2(9.8)(8)}$

$v = 12.5 ms^{-1}$

**Q1d)** $s = ut + \frac{1}{2}at^2$

$8 = 0 + \frac{1}{2}(9.8)t^2$

$8 = 4.9t^2$

$t = \sqrt{\frac{8}{4.9}} = 1.28 secs$

**Q2a)**

A→B

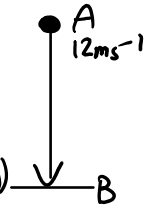
s

u = 12

v

a = 9.8 (+ve, ∵ accel due to gravity)

t = 2



Take downwards as +ve

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

$s = 12(2) + \frac{1}{2}(9.8)(2^2)$

$s = 43.6m$

**Q2b)** $v = u + at$

$v = 12 + 9.8(2)$

$v = 31.6 ms^{-1}$

If you need help on this chapter
[A-Level Maths | Mechanics Year 1 | 9.5 - Vertical motion under gravity Walkthrough | Edexcel]

**Q3a)**

A→B

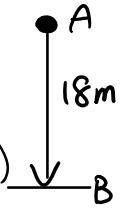
s = 18

u

v

a = 9.8 (+ve, ∵ accel due to gravity)

t = 1



Take downwards as +ve

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

$18 = u(1) + \frac{1}{2}(9.8)(1^2)$

$18 = u + 4.9$

$u = 13.1 ms^{-1}$

**Q3b)** $v = u + at$

$v = 13.1 + 9.8(1) = 22.9 ms^{-1}$

**Q4a)**

A→C

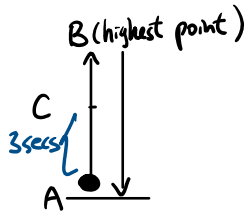
s

u = 36

v = ?

a = -9.8 (-ve, ∵ decel due to gravity)

t = 3



Take upwards as +ve

$v = u + at$

$v = 36 + (-9.8)(3)$

$v = 6.6 ms^{-1}$

**Q4b)** A→A (full flight of ball)

s = 0 (return to original point)

u = 36

v

a = -9.8

t = ?

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

$0 = 36t + \frac{1}{2}(9.8)t^2$

$0 = -4.9t^2 + 36t$

(c) (ii)

$v = 12 + 9.8(2)$

$v = \underline{\underline{31.6 ms^{-1}}}$

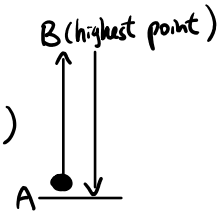
$0 = -4.9t^2 + 36t$

$t = 0$ or $\underline{\underline{7.35 secs}}$

# 9.5 - Vertical motion under gravity

**Q5a)** A → B

$s = ?$
$u = 11$
$v = 0$ (vel is 0 at highest point)
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t =$



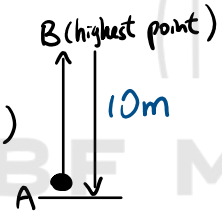

Take upwards as +ve

$v^2 = u^2 + 2as$
$0 = 11^2 + 2(-9.8)s$
$0 = 121 - 19.6s$
$s = \frac{121}{19.6} = \underline{\underline{6.17\text{ m}}}$

**Q5b)** $v = u + at$
$0 = 11 + (-9.8)t$
$9.8t = 11$
$t = \underline{\underline{1.22\text{ secs}}}$

**Q6a)** A → B

$s = 10$
$u = u$
$v = 0$ (vel is 0 at highest point)
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t =$




Take upwards as +ve

$v^2 = u^2 + 2as$
$0 = u^2 + 2(-9.8)(10)$
$0 = u^2 - 196$
$u = \underline{\underline{14\text{ ms}^{-1}}}$

**Q6b)** Method 1
Using A → B

$v = u + at$
$0 = 14 + (-9.8)t$
$9.8t = 14$
$t = \frac{14}{9.8} = 1.43$ secs

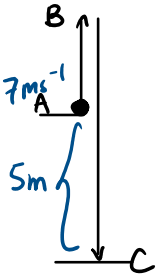
Method 2
Using A → A (full flight)

$s = 0$
$u = 14$
$v$
$a = -9.8$
$t$

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

**Q7a)** A → C

$s = -5$ (-ve, ∵ C is below A)
$u = 7$
$v =$
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t = ?$




Take upwards as +ve

$s = ut + \frac{1}{2}at^2$
$-5 = 7t + \frac{1}{2}(-9.8)(t^2)$
$0 = -4.9t^2 + 7t + 5$
$t = \underline{\underline{1.95\text{ secs}}}$ or $-0.522$

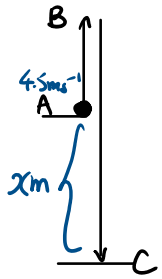
**Q7b)** $v = u + at$
$v = 7 + (-9.8)(1.95)$
$v = -12.1$ ← -ve because we took upwards as +ve and the particle is falling.

Speed $= \underline{\underline{12.1\text{ ms}^{-1}}}$

**Q7c)** New $t$ value will be greater than the value found in (a) because the inclusion of air resistance will reduce the acceleration, hence longer time will be expected.

**Q8)** A → C

$s = -x$ (-ve, ∵ C is below A)
$u = 4.5$
$v =$
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t = 2$




Take upwards as +ve

$s = ut + \frac{1}{2}at^2$
$-x = 4.5(2) + \frac{1}{2}(-9.8)(2^2)$
$-x = -10.6$
$x = \underline{\underline{10.6\text{ m}}}$

$t = \frac{14}{9.8} = 1.43$ secs

Total time $= 1.43 \times 2$

$= 2.86$ secs

b

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

$0 = 14t + \frac{1}{2}(-9.8)t^2$

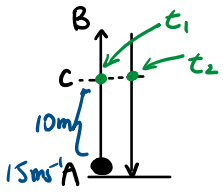
$0 = -4.9t^2 + 14t$

$t = 0$ or $2.86$ secs

# 9.5 - Vertical motion under gravity

**Q9)** $A \to C$

$s = 10$
$u = 15$
$v =$
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t = ?$




Take upwards as +ve

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

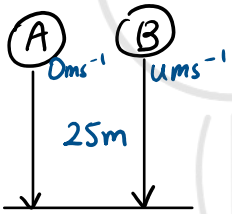
$10 = 15t + \frac{1}{2}(-9.8)t^2$

$0 = -4.9t^2 + 15t - 10$

$t = 2.08$ or $0.98$
$(t_2)$ $(t_1)$

Time spent above 10m $= (t_2 - t_1)$ $2.08 - 0.98$
$= 1.1$ secs


**Q10)** (A) $s = 25$
$u = 0$
$v$
$a = 9.8$ (+ve, ∵ accel)
$t$




Take downwards as +ve

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

$25 = 0 + \frac{1}{2}(9.8)t^2$

$25 = 4.9t^2$

$t = \sqrt{\frac{25}{4.9}} = 2.26$ secs

(B) $s = 25$
$u = u$
$v$
$a = 9.8$
$t = 2.26 - 1 = 1.26$

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

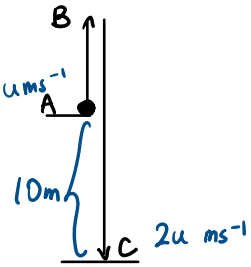
$25 = u(1.26) + \frac{1}{2}(9.8)(1.26)^2$

$25 = 1.26u + 7.78$

$u = \frac{25 - 7.78}{1.26} = 13.7\ ms^{-1}$

**Q11a)** $A \to C$

$s = -10$ (-ve, ∵ C is below A)
$u = u$
$v = -2u$
$a = -9.8$ (-ve, ∵ decel due to gravity)
$t =$




Take upwards as +ve

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

$(-2u)^2 = u^2 + 2(-9.8)(-10)$

$4u^2 = u^2 + 196$

$3u^2 = 196$

$u = \sqrt{\frac{196}{3}} = 8.08\ ms^{-1}$

**Q11b)** $v = u + at$

$-2u = u + (-9.8)t$

$-3u = -9.8t$

$3(8.08) = 9.8t$

$t = \frac{3(8.08)}{9.8} = 2.47$ secs

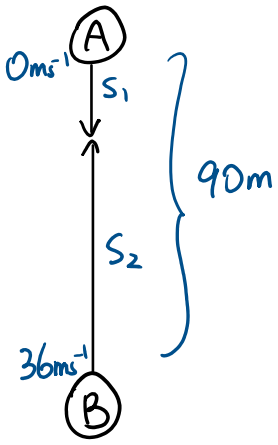
$u = \frac{25 - 7.78}{1.26} = \underline{\underline{13.7 \text{ ms}^{-1}}}$

# 9.5 - Vertical motion under gravity

Q12)

For (A): Take downwards as +ve

$s = s_1$
$u = 0$ (from rest)
$v$
$a = 9.8$ (+ve, ∵ accelerating due to gravity)
$t = t$




$s = ut + \frac{1}{2}at^2$
$s_1 = 0 + \frac{1}{2}(9.8)t^2$
$s_1 = 4.9t^2$

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For (B): Take upwards as +ve

$s = s_2$
$u = 36$
$v$
$a = -9.8$ (-ve, ∵ decelerating due to gravity)
$t = t$

$s = ut + \frac{1}{2}at^2$
$s_2 = 36t + \frac{1}{2}(-9.8)t^2$
$s_2 = 36t - 4.9t^2$



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$s_1 + s_2 = 90$

$4.9t^2 + 36t - 4.9t^2 = 90$

$36t = 90$

$t = \frac{90}{36} = \underline{2.5 \text{ secs}}$

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