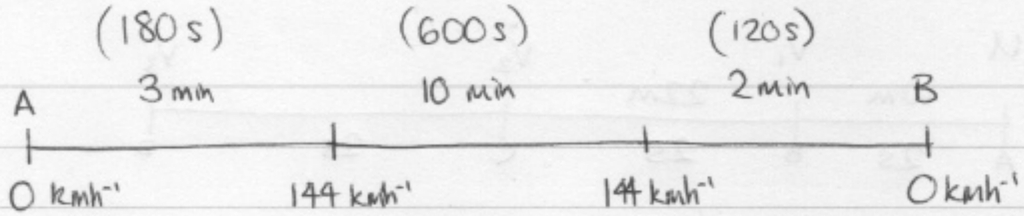
1.



$144\ kmh^{-1} = 144\,000\ mh^{-1}$
$= 40\ ms^{-1}$

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

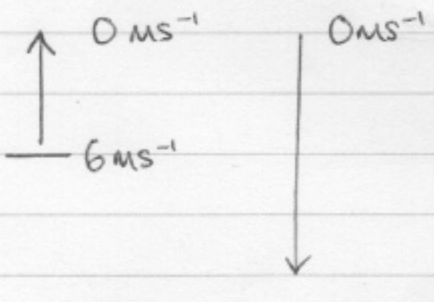
$s_1 = \frac{1}{2}(0+40) \times 180 = 3600\ m$

$s_2 = \frac{1}{2}(40+40) \times 600 = 24000\ m$

$s_3 = \frac{1}{2}(40+0) \times 120 = 2400\ m$

Total distance $= 3600 + 24000 + 2400$
$= \underline{30\ km}$

2.



Total time = 2s

Up: $v = u + at$
$0 = 6 - 9.8t$
$t = 6/9.8$
$\underline{t = 0.612\ s}$

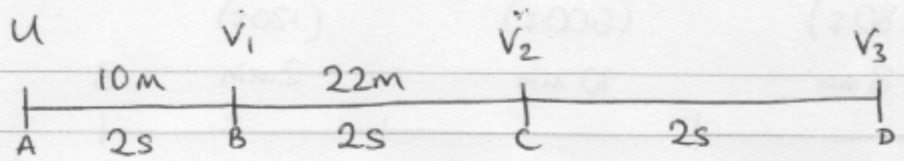
Down: $v = u + at$
$v = 0 - 9.8(2 - 0.612)$
$\underline{v = -13.6\ ms^{-1}}$

Up: $v^2 = u^2 + 2as$
$s = \frac{v^2 - u^2}{2a}$
$s = \frac{0^2 - 6^2}{2 \times -9.8}$
$s = 1.84\ m$

Down: $s = \frac{v^2 - u^2}{2a}$
$s = \frac{(-13.6)^2 - 0^2}{2 \times 9.8}$
$s = 9.44\ m$

Initial height $= 9.44 - 1.84 = \underline{7.6\ m}$

3.



AB :

$$s = ut + \tfrac{1}{2}at^2$$
$$10 = 2u + \tfrac{1}{2}a \times 4$$
$$10 = 2u + 2a \quad \text{—— ①}$$

AC :

$$s = ut + \tfrac{1}{2}at^2$$
$$32 = 4u + \tfrac{1}{2} \times a \times 16$$
$$32 = 4u + 8a \quad \text{—— ②}$$

① × 2 : $20 = 4u + 4a$ —— ③

② − ③ : $12 = 4a$

$$a = 3 \text{ ms}^{-2}$$

Substitute into ① : $10 = 2u + 6$

$$u = 2 \text{ ms}^{-1}$$

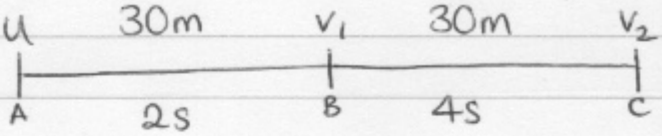
AD :

$$s = ut + \tfrac{1}{2}at^2$$
$$s = 2 \times 6 + \tfrac{1}{2} \times 3 \times 6^2$$
$$s = 12 + 54$$
$$s = 66\text{m}$$

CD : $66\text{m} - 22\text{m} - 10\text{m} = 34\text{m}$

The particle moves 34m in the next 2s.

4.



(i) AB: $s = ut + \frac{1}{2}at^2$

$30 = 2u + \frac{1}{2}a \times 4$

$30 = 2u + 2a$ —— ①

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

$60 = 6u + \frac{1}{2}a \times 6^2$

$60 = 6u + 18a$ —— ②

① × 3: $90 = 6u + 6a$ —— ③

② − ③: $-30 = 12a$

$a = -\frac{30}{12}$

$\underline{a = -2 \cdot 5 \text{ ms}^{-2}}$

Substitute into ①: $30 = 2u - 5$

$\underline{u = 17 \cdot 5 \text{ ms}^{-1}}$

(ii) Deceleration of $2 \cdot 5 \text{ms}^{-2}$

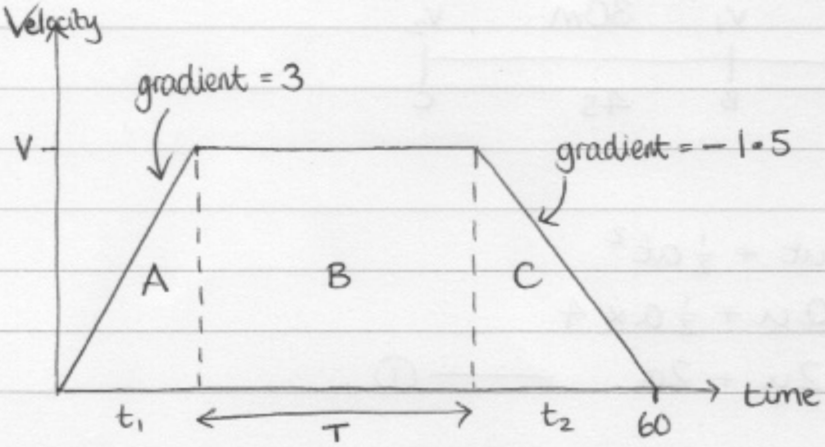
(iii) $v = u + at$

$t = \frac{v-u}{a}$

$t = \frac{0 - 17.5}{-2 \cdot 5}$

$\underline{t = 7\text{s}}$

5.



Total area under graph = 1000 m.

From gradient of triangle A: $\frac{V}{t_1} = 3$ $V = 3t_1$ —— ①

From gradient of triangle B: $\frac{V}{t_2} = 1.5$ $V = 1.5t_2$ —— ②

So $3t_1 = 1.5t_2$

$2t_1 = t_2$ —— ③

Total time: $T + t_1 + t_2 = 60$

substituting ③: $T + 3t_1 = 60$

$T = 60 - 3t_1$ —— ④

Area under graph (trapezium): $\frac{1}{2}(60 + T) \times V = 1000$

Substitute ① & ④: $\frac{1}{2}(60 + 60 - 3t_1) \times 3t_1 = 1000$

$(120 - 3t_1) \times 3t_1 = 2000$

$9t_1^2 - 360t_1 + 2000 = 0.$

Use the quadratic formula: $t_1 = \frac{360 \pm \sqrt{360^2 - 4 \times 9 \times 2000}}{2 \times 9}$

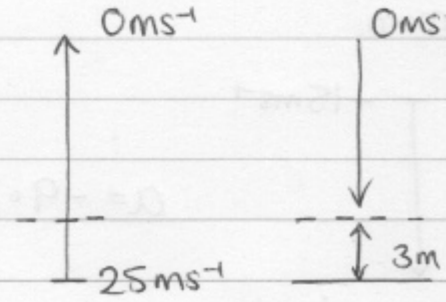
$t_1 = \frac{360 \pm 240}{18} = 6\frac{2}{3}$ seconds.

From ③: $t_2 = 13\frac{1}{3}$ seconds.

From ④: $T = 40$ s

From ①: $V = 20$ ms^{-1}

6



$a = -9.8 ms^{-2}$

<u>Up:</u> $v^2 = u^2 + 2as$

$0^2 = 25^2 - 2 \times 9.8 \times s$

$s = \frac{3125}{98} = 31.89 m.$

$31.89 - 3 = 28.89 m.$

<u>Down:</u> $s = ut + \frac{1}{2}at^2$

$28.89 = 0t + \frac{1}{2} \times 9.8 \times t^2$

$t^2 = \frac{28.89}{4.9}$

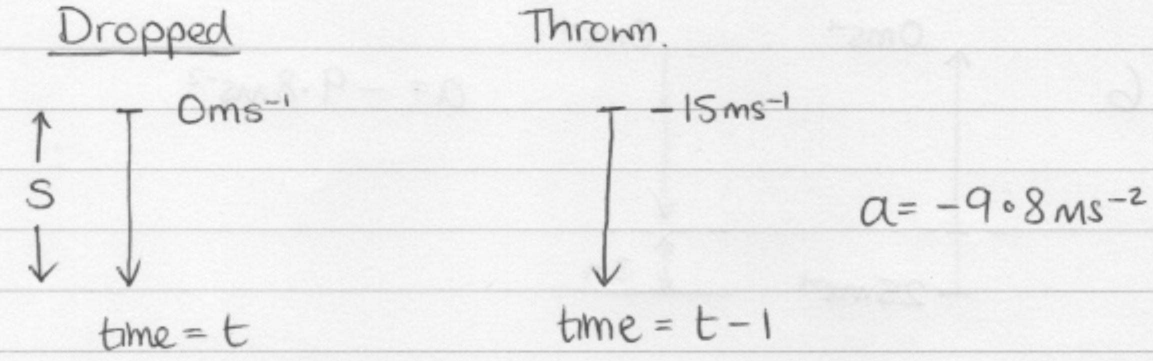
$t = 2.43s$

For constant acceleration with no resistance forces, the time to travel upwards over this distance will be the same as the time to travel downwards

Total time above 3m $= 2 \times 2.43s$

$= \underline{4.86s}$

7.



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

Dropped: $s = 0t + \frac{1}{2} \times (-9.8)t^2$

$s = -4{\cdot}9t^2$ —— ①

Thrown: $s = -15(t-1) + \frac{1}{2} \times (-9.8)(t-1)^2$

$s = -15t + 15 - 4{\cdot}9(t^2 - 2t + 1)$

$s = -15t + 15 - 4{\cdot}9t^2 + 9{\cdot}8t - 4{\cdot}9$

$s = -4{\cdot}9t^2 - 5{\cdot}2t + 10{\cdot}1$ —— ②

From ① & ②: $-5{\cdot}2t + 10{\cdot}1 = 0$

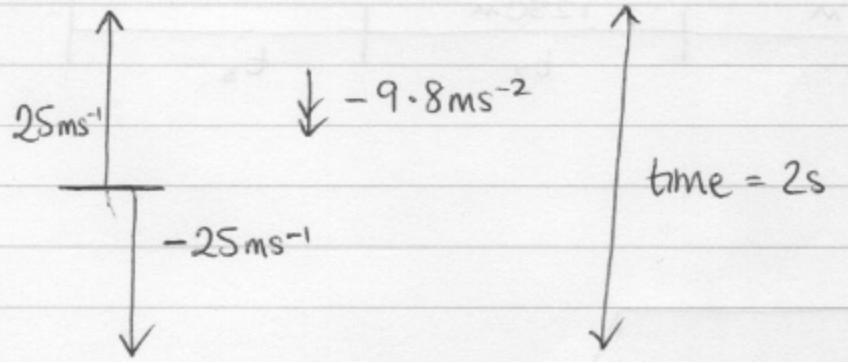
$t = \frac{10\cdot1}{5\cdot2} = 1{\cdot}94$ seconds

Substituting into ①: $s = -4{\cdot}9t^2$

$s = -18{\cdot}5\ m$

The cliff is 18·5 m high.

8.



<u>Up</u>: $s = ut + \frac{1}{2}at^2$

$s = 25 \times 2 + \frac{1}{2} \times (-9.8) \times 2^2$

$s = 50 - 19.6$

$\underline{s = 30.4\,m}$

<u>Down</u>: $s = ut + \frac{1}{2}at^2$

$s = -25 \times 2 + \frac{1}{2} \times (-9.8) \times 2^2$

$s = -50 - 19.6$

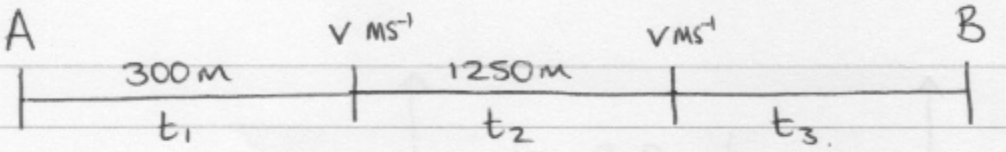
$\underline{s = -69.6\,m}$

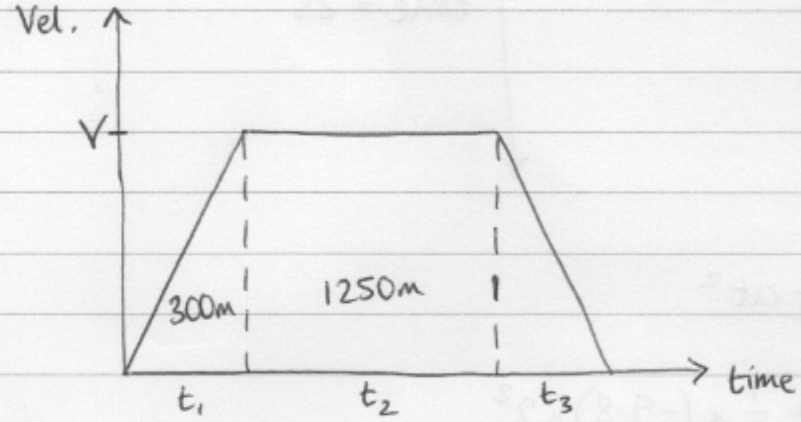
Difference in displacement = $30.4 + 69.6 = \underline{100\,m}$

<u>Note</u>: this difference is the same as if the balls were thrown horizontally with no acceleration acting, travelling at $25\,ms^{-1}$ for 2s in opposite directions.

Since the acceleration due to gravity is constant and acts on both balls equally, this effect is "cancelled out".

9.





Area$_1$ $\Rightarrow$ $\frac{1}{2}Vt_1 = 300$ $\qquad t_1 = \frac{600}{V}$ —— ①

Area$_2$ $\Rightarrow$ $Vt_2 = 1250$ $\qquad t_2 = \frac{1250}{V}$ —— ②

We are told in the question that $2t_1 = 3t_3$

$t_3 = \frac{2}{3}t_1$ $\qquad t_3 = \frac{400}{V}$ —— ③

Total time : $t_1 + t_2 + t_3 = 180$ seconds.

using ①, ② & ③: $\frac{600}{V} + \frac{1250}{V} + \frac{400}{V} = 180$

$600 + 1250 + 400 = 180\,V$

$V = \frac{2250}{180}$

$\underline{V = 12 \cdot 5 \text{ ms}^{-1}}$

Then $t_1 = \frac{600}{12 \cdot 5} = 48$ s

$t_2 = \frac{1250}{12 \cdot 5} = 100$ s

$t_3 = \frac{400}{12 \cdot 5} = 32$ s

Distance travelled during $t_3 = \frac{1}{2} \times 32 \times 12 \cdot 5$

$= 200$ m

Total distance from A to B

$= 200 \text{ m} + 1250 \text{ m} + 300 \text{ m}$

$= \underline{1750 \text{ m}}$