

## LC 2014: PAPER 1

**QUESTION 9 (75 MARKS)**

**Question 9 (a)**

Time, $t$	0	1	2	3	4	5	6	7	8	9	10
Height, $h$	0	9	16	21	24	<b>25</b>	<b>24</b>	<b>21</b>	<b>16</b>	9	0

$$h = 10t - t^2$$

$$t = 0 : h = 10(0) - (0)^2 = 0 \text{ m}$$

$$t = 1 : h = 10(1) - (1)^2 = 10 - 1 = 9 \text{ m}$$

$$t = 2 : h = 10(2) - (2)^2 = 20 - 4 = 16 \text{ m}$$

$$t = 3 : h = 10(3) - (3)^2 = 30 - 9 = 21 \text{ m}$$

$$h = 10t - t^2$$

$$t = 4 : h = 10(4) - (4)^2 = 40 - 16 = 24 \text{ m}$$

$$t = 9 : h = 10(9) - (9)^2 = 90 - 81 = 9 \text{ m}$$

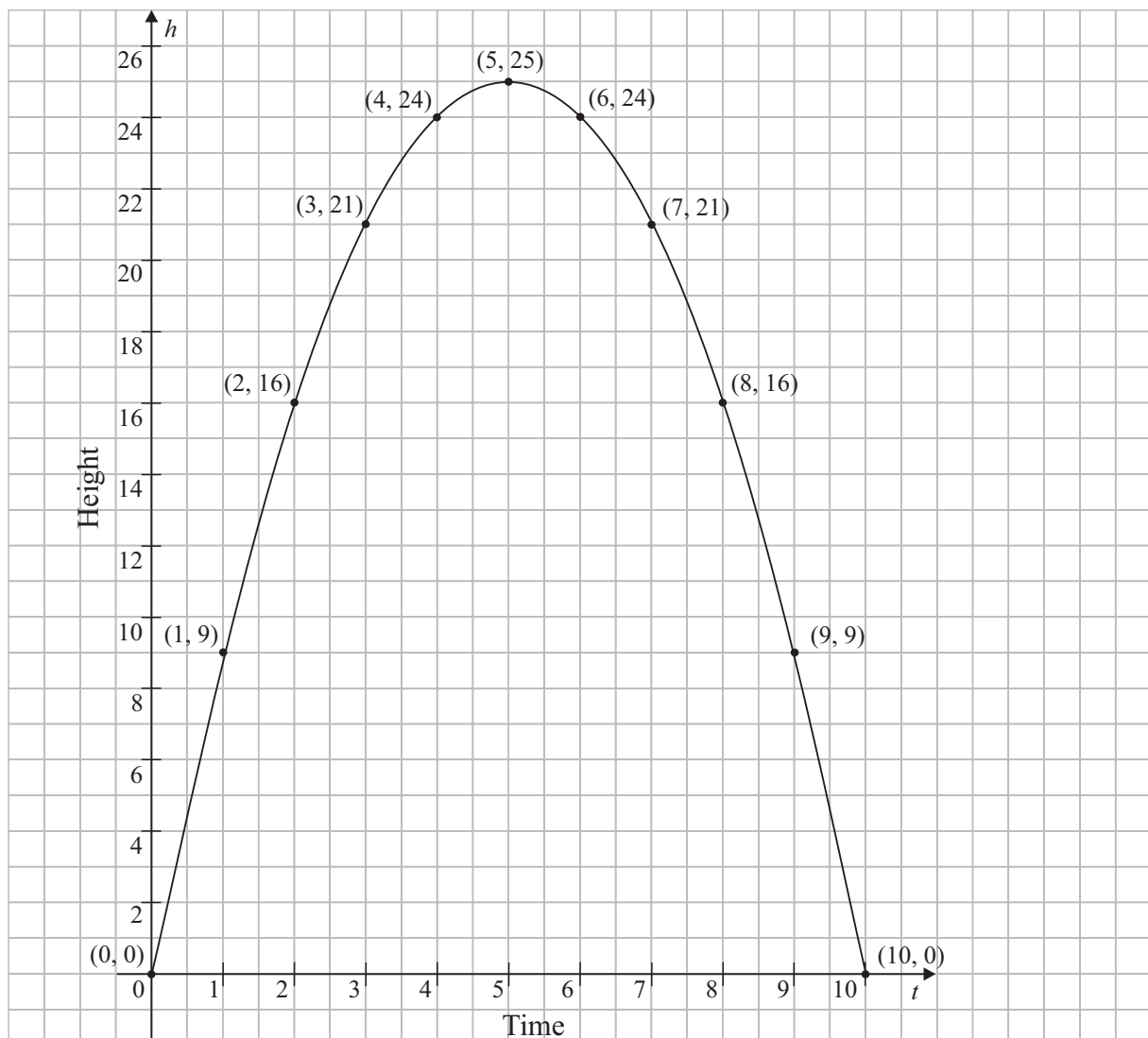
$$t = 10 : h = 10(10) - (10)^2 = 100 - 100 = 0 \text{ m}$$

**MARKING SCHEME NOTES**

**Question 9 (a) [Scale 15C (0, 5, 10, 15)]**

- 5:**
- At least one correct value
  - Substitutes correctly at least once
- 10:**
- 5 or 6 correct values

**Question 9 (b)**



**MARKING SCHEME NOTES**

**Question 9 (b) [Scale 15C (0, 5, 10, 15)]**

**5:** • At least 1 point plotted correctly

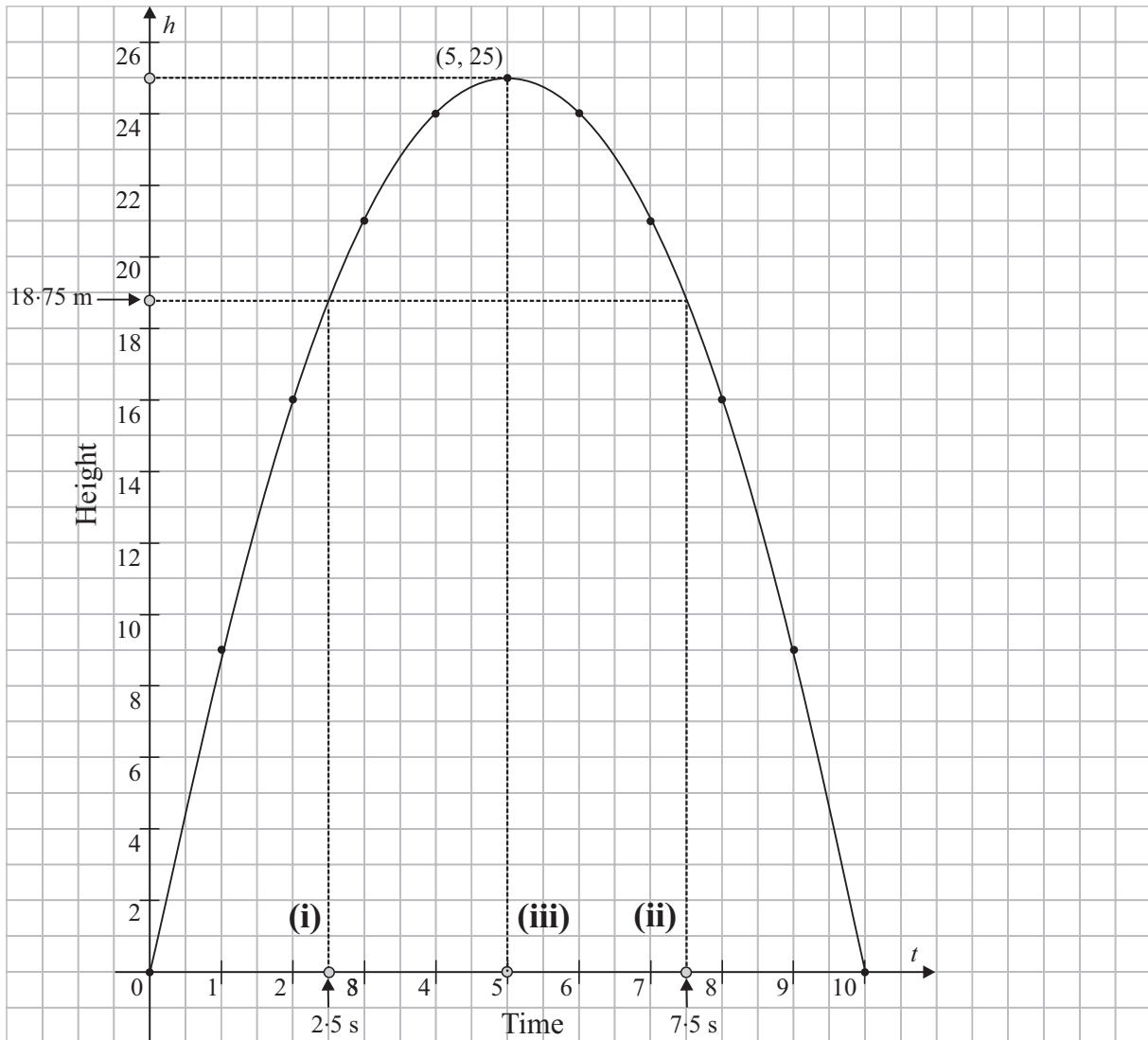
**10:** • Points connected with straight edge

• At least 5 points plotted correctly and joined

• All points plotted correctly but not joined

**NOTE:** Answers to (c) (i) (ii) (iii) based on candidate's graph. Tolerance  $\pm\frac{1}{2}$  unit

**Question 9 (c)**



- (i) Go to 2.5 s on the time axis. Draw a vertical line up until it meets the curve and then a horizontal line out to the height axis. Read off the height  $h$ .  
 $\therefore h = 18.75 \text{ m}$
- (ii) Go to 18.75 m on the height axis. Draw a horizontal line across until it meets the curve for the second time. Draw a vertical line down to the time axis. Read off the time  $t$ .  
 $\therefore t = 7.5 \text{ s}$
- (iii) Maximum point (5, 25)

**MARKING SCHEME NOTES**

**Question 9 (c) (i) [Scale 5B (0, 2, 5)]**

2: • Uses  $t = 2.5$  to solve

**Question 9 (c) (ii) [Scale 5B (0, 2, 5)]**

2: • Correct  $h$  ordinate indicated on graph

**Question 9 (c) (iii) [Scale 5B (0, 2, 5)]**

2: • Only one ordinate given  
• Coordinates reversed

**Question 9 (d)**

(i)  $(6, 24) = (x_1, y_1), (7, 21) = (x_2, y_2)$

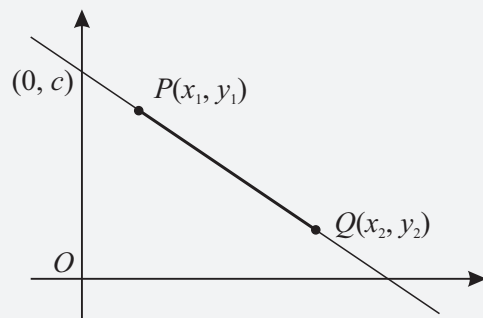
$$m = \frac{21 - 24}{7 - 6} = -3$$

(ii) Yes. For a one-second time interval, the rocket travels 5 m compared to 3 m in part (i). It has a greater negative slope.

$(7, 21) = (x_1, y_1), (8, 16) = (x_2, y_2)$

$$m = \frac{16 - 21}{8 - 7} = -5$$

**FORMULAE AND TABLES BOOK  
Co-ordinate geometry: Line**



Slope of  $PQ$  [page 18]

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

**MARKING SCHEME NOTES**

**Question 9 (d) (i) (ii) [Scale 10D (0, 3, 5, 8, 10)]**

3: • Any work of merit e.g. correct formula given

5: • One slope calculated correctly

• Both slopes calculated but with errors

• Correct answer to (ii) but no slope in (i)

8: • Both slopes calculated correctly with incorrect or no conclusion

**Question 9 (e)**

(i)  $h = 10t - t^2$   
 $\frac{dh}{dt} = 10 - 2t$

**FORMULAE AND TABLES BOOK**  
**Calculus: Derivatives [page 25]**

$$y = x^n \Rightarrow \frac{dy}{dx} = nx^{n-1}$$

(ii)  $\frac{dh}{dt} = 0 \Rightarrow 10 - 2t = 0$   
 $10 = 2t$   
 $\therefore t = 5 \text{ s}$

FIND TURNING POINTS (LOCAL MAXIMUM/MINIMUM)  
 Put  $\frac{dy}{dx} = 0$  and solve for  $x$

$h_{\text{Max}} = 10(5) - (5)^2 = 50 - 25 = 25 \text{ m}$  ← Put  $t = 5 \text{ s}$  into the formula for height to find the maximum height  $h_{\text{Max}}$

(iii)  $v = \frac{dh}{dt} = 10 - 2t$   
 $t = 3 : v = 10 - 2(3)$   
 $= 10 - 6$   
 $= 4 \text{ m/s}$

**FORMULA: Velocity/Speed**

$$\text{Velocity (Speed) } v = \frac{\text{Change in distance}}{\text{Change in time}} = \frac{ds}{dt}$$

**Note:** Distance in this case is height.

**MARKING SCHEME NOTES**

**Question 9 (e) (i) [Scale 5B (0, 2, 5)]**

2: • 1 term differentiated correctly

**Question 9 (e) (ii) [Scale 5C (0, 2, 3, 5)]**

2: •  $\frac{dh}{dt} = 0$

• Use of their  $\frac{dh}{dt}$

3: • The candidate's value of  $t$  substituted into expression for  $h$

• Solves their  $\frac{dh}{dt} = 0$  correctly

**Question 9 (e) (iii) [Scale 5B (0, 2, 5)]**

2: • Recognition that speed =  $\frac{dh}{dt}$

• 3 substituted into  $\frac{dh}{dt}$  and stops

**Question 9 (f)**

You can find the slope of the tangent to a curve by differentiation.

Solve for  $t$  by putting the slope equal to 4.

Find the corresponding value of  $h$  by putting this value of  $t$  into the height formula.

$$\frac{dh}{dt} = 10 - 2t = 2$$

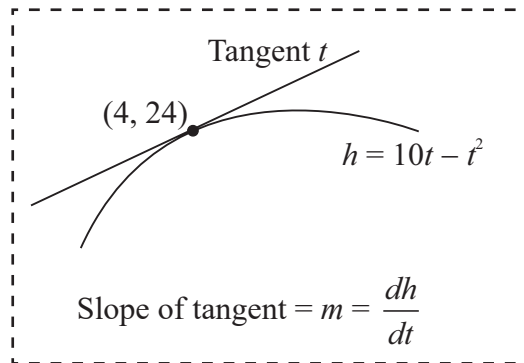
$$10 - 2 = 2t$$

$$8 = 2t$$

$$\therefore t = 4$$

$$h = 10(4) - (4)^2 = 40 - 16 = 24$$

The co-ordinates are (4, 24).

**MARKING SCHEME NOTES****Question 9 (f) [Scale 5C (0, 2, 3, 5)]**

2: • Correct structure to  $\frac{dh}{dt} = 2$

• Correct answer with no work or without calculus

3: • The candidate's value of  $t$  substituted into expression for  $h$  and stops or continues with errors

• Solves their  $\frac{dh}{dt} = 2$  correctly