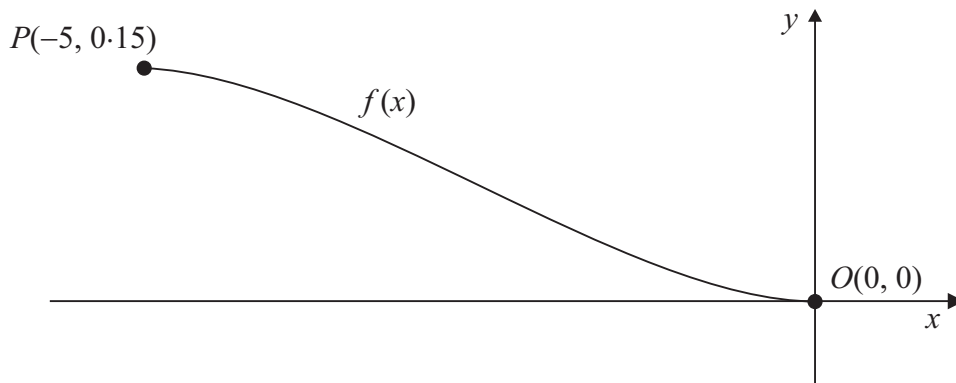


**LC 2015 (SET B): PAPER 1****QUESTION 7 (50 MARKS)****Question 7 (a) (i)**

$$f(x) = 0.0024x^3 + 0.018x^2 + cx + d \leftarrow (0, 0) \in f(x) \Rightarrow f(0) = 0.$$

$$f(0) = 0 \Rightarrow 0.0024(0)^3 + 0.018(0)^2 + c(0) + d = 0$$

$$\therefore d = 0$$

**MARKING SCHEME NOTES****Question 7 (a) (i) [Scale 5B (0, 2, 5)]**

2: • Recognises  $x = 0$

**Question 7 (a) (ii)**

$$f(x) = 0.0024x^3 + 0.018x^2 + cx \leftarrow (-5, 0.15) \in f(x) \Rightarrow f(-5) = 0.15.$$

$$f(-5) = 0.15 \Rightarrow 0.0024(-5)^3 + 0.018(-5)^2 + c(-5) = 0.15$$

$$0.15 - 5c = 0.15$$

$$5c = 0$$

$$\therefore c = 0$$

**or**

The plane land horizontally at  $O$ . Therefore  $f'(x) = 0$  when  $x = 0$ .

$$f(x) = 0.0024x^3 + 0.018x^2 + cx$$

$$f'(x) = 0.0072x^2 + 0.036x + c$$

$$f'(0) = 0 \Rightarrow f'(0) = 0.0072(0)^2 + 0.036(0) + c = 0$$

$$\therefore c = 0$$

**MARKING SCHEME NOTES****Question 7 (a) (ii) [Scale 5B (0, 2, 5)] Note: two solutions**1st solution

2: • Uses  $x = -5$  or  $f(x) = 0.15$

5: • Begins with  $c = 0$  and shows  $f(-5) = 0.15$  or similar

**or**

2nd solution

2: • Uses  $x = -5$

• Gets  $f'(x)$

• Uses  $f'(x) = 0$  when  $x = 0$

**Question 7 (b) (i)**

$$f(x) = 0.0024x^3 + 0.018x^2$$

$$f'(x) = 0.0072x^2 + 0.036x$$

$$f'(-4) = 0.0072(-4)^2 + 0.036(-4)$$

$$= -\frac{18}{625}$$

$$= -0.0288$$

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

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

$$y = [f(x)]^n \Rightarrow \frac{dy}{dx} = n[f(x)]^{n-1} \times f'(x)$$

**MARKING SCHEME NOTES**

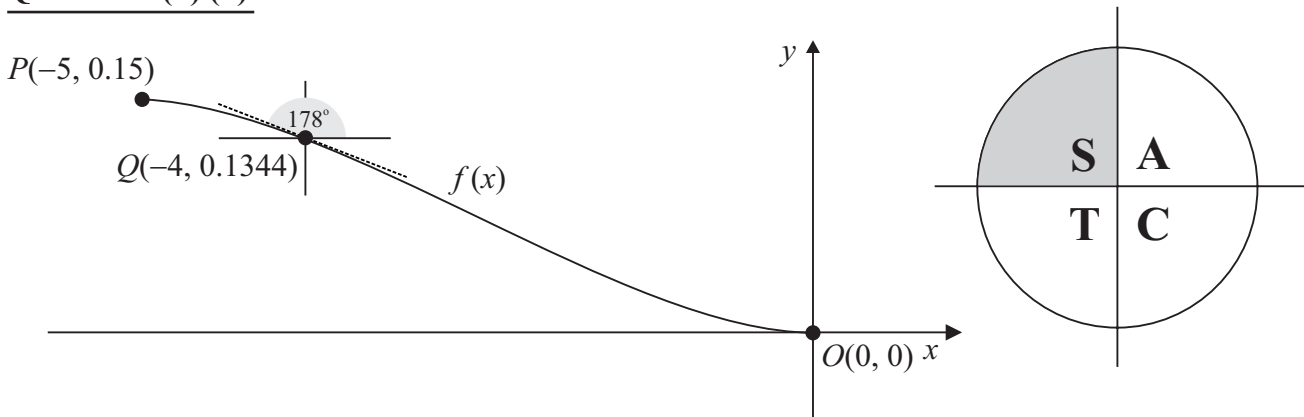
**Question 7 (b) (i) [Scale 10C (0, 3, 7, 10)]**

**3:** • Any term correctly differentiated

**7:** • Correct differentiation

**10:** •  $-\frac{18}{625}$  is a correct answer

**Question 7 (b) (ii)**



The slope of the tangent to  $f(x)$  at  $x = -4$  is given by  $f'(-4)$ . The slope is also the  $\tan$  the angle makes with the  $+x$ -axis.

$$\tan \theta = -0.0288 \text{ [Second quadrant]}$$

$$\alpha = \tan^{-1}(0.0288) = 1.65^\circ \text{ [Reference angle in first quadrant]}$$

$$\theta = 180^\circ - 1.65^\circ \approx 178^\circ \text{ [Second quadrant]}$$

Angle of descent =  $2^\circ$

**MARKING SCHEME NOTES**

**Question 7 (b) (ii) [Scale 5B (0, 2, 5)]**

**2:** • Recognition of connection between slope and  $\tan \theta$

• Any right angled triangle

**Question 7 (c)**

$$f'(x) = 0.0072x^2 + 0.036x$$

$$f''(x) = 0.0144x + 0.036$$

$$f''(x) = 0 \Rightarrow 0.0144x + 0.036 = 0$$

$$\therefore x = -2.5$$

POINT OF INFLECTION: Put  $\frac{d^2y}{dx^2} = 0$   
 or  $f''(x) = 0$  and solve for  $x$ .

$$f(x) = 0.0024x^3 + 0.018x^2$$

$$f(-2.5) = 0.0024(-2.5)^3 + 0.018(-2.5)^2 = 0.075$$

Point of inflection  $(-2.5, 0.075)$

**MARKING SCHEME NOTES**

**Question 7 (c) [Scale 10D (0, 2, 5, 8, 10)]**

- 2: • Some correct differentiation of  $f'(x)$   
 • Mention of  $f'(x)$   
 5: • Correct  $f''(x)$   
 8: • Value of  $x$  substituted

**Question 7 (d) (i)**

$$\begin{aligned}
 y &= 0.0024x^3 + 0.018x^2 \\
 f(-x-5) &= 0.0024(-x-5)^3 + 0.018(-x-5)^2 \\
 &= (-x-5)^2[0.0024(-x-5) + 0.018] \\
 &= (x^2 + 10x + 25)[-0.0024x - 0.012 + 0.018] \\
 &= (x^2 + 10x + 25)[-0.0024x + 0.006] \\
 &= -0.0024x^3 + 0.006x^2 - 0.024x^2 + 0.06x - 0.06x + 0.15 \\
 &= -0.0024x^3 - 0.018x^2 + 0.15 \\
 &= -(0.0024x^3 + 0.018x^2) + 0.15 \\
 &= -y + 0.15
 \end{aligned}$$

**MARKING SCHEME NOTES**

**Question 7 (d) (i) [Scale 5C (0, 2, 4, 5)]**

- 2: • Some correct substitution  
 4: • Correct expansions

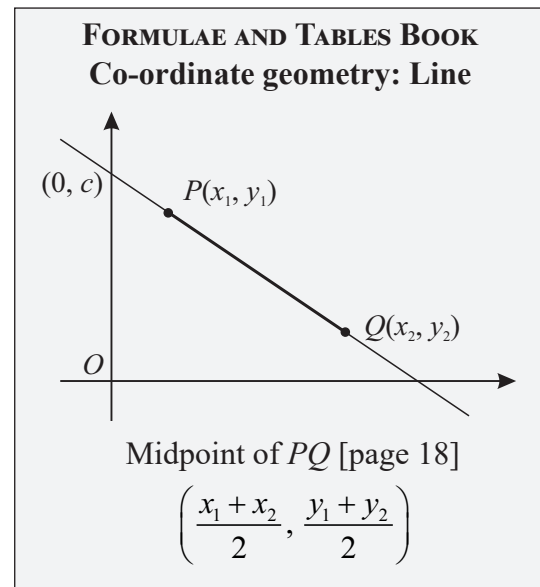
**Question 7 (d) (ii)**

$$\begin{aligned}
 -x - 5 &\rightarrow -2.5 [x + 2.5] \\
 -y + 0.15 &\rightarrow 0.075 [y - 0.075] \\
 -x - 5 &\rightarrow -2.5 \rightarrow x \\
 -y + 0.15 &\rightarrow 0.075 \rightarrow y \\
 \therefore (-x - 5, -y + 0.15) &\rightarrow (-2.5, 0.075) \rightarrow (x, y)
 \end{aligned}$$

**or**

Let  $(x, y)$  be the image.  
 The point of inflection will be the midpoint of  $(-x - 5, -y + 0.15)$  and  $(x, y)$ .

$$\begin{aligned}
 \text{Midpoint} &= \left( \frac{-x - 5 + x}{2}, \frac{-y + 0.15 + y}{2} \right) \\
 &= (-2.5, 0.075)
 \end{aligned}$$



**MARKING SCHEME NOTES**

**Question 7 (d) (ii) [Scale 10C (0, 4, 8, 10)] Note: two solutions**

1st solution

**4:** • Work leading to change in  $x$ -value or  $y$ -value

**8:** • Correct change in  $x$  and  $y$  values

**or**

2nd solution

**4:** • Uses  $(x, y)$  as image, and no more

**8:** • Effort at calculating mid-point