

IB Diploma

MATHEMATICS AA

SL P2

2012 — 2023

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1 - (MAT/21_SL_Summer_2013_Q6) - Functions - Roots, Graphs

Let f and g be functions such that $g(x) = 2f(x+1) + 5$.

(a) The graph of f is mapped to the graph of g under the following transformations:

vertical stretch by a factor of k , followed by a translation $\begin{pmatrix} p \\ q \end{pmatrix}$.

Write down the value of

(i) k ;

(ii) p ;

(iii) q .

[3 marks]

(b) Let $h(x) = -g(3x)$. The point $A(6, 5)$ on the graph of g is mapped to the point A' on the graph of h . Find A' .

[3 marks]

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2 - (MAT/20_SL_Winter_2014_Q1) - Functions - Roots

Let $f(x) = 2x + 3$ and $g(x) = x^3$.

(a) Find $(f \circ g)(x)$. [2]

(b) Solve the equation $(f \circ g)(x) = 0$. [3]

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3 - (MAT/21_SL_Summer_2015_Q4) - Functions - Roots

Let $f(x) = \frac{2x-6}{1-x}$, for $x \neq 1$.

(a) For the graph of f

- (i) find the x -intercept;
- (ii) write down the equation of the vertical asymptote;
- (iii) find the equation of the horizontal asymptote.

[5]

(b) Find $\lim_{x \rightarrow \infty} f(x)$.

[2]

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4 - (MAT/20_SL_Winter_2016_Q1) - Functions - Roots

Let $f(x) = x^2 + 2x + 1$ and $g(x) = x - 5$, for $x \in \mathbb{R}$.

- (a) Find $f(8)$. [2]
- (b) Find $(g \circ f)(x)$. [2]
- (c) Solve $(g \circ f)(x) = 0$. [3]

5 - (MAT/21_SL_Summer_2014_Q10) - Functions - Roots, Differentiation

Let $f(x) = \frac{3x}{x-q}$, where $x \neq q$.

- (a) Write down the equations of the vertical and horizontal asymptotes of the graph of f . [2]

The vertical and horizontal asymptotes to the graph of f intersect at the point $Q(1, 3)$.

- (b) Find the value of q . [2]

- (c) The point $P(x, y)$ lies on the graph of f . Show that $PQ = \sqrt{(x-1)^2 + \left(\frac{3}{x-1}\right)^2}$. [4]

- (d) Hence find the coordinates of the points on the graph of f that are closest to $(1, 3)$. [6]

ANSWERS

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1 - (MAT/21_SL_Summer_2013_Q6) - Functions - Roots, Graphs

(a) (i) $k = 2$

(ii) $p = -1$

(iii) $q = 5$

(b) recognizing one transformation

eg horizontal stretch by $\frac{1}{3}$, reflection in x -axis,

A' is $(2, -5)$

2 - (MAT/20_SL_Winter_2014_Q1) - Functions - Roots

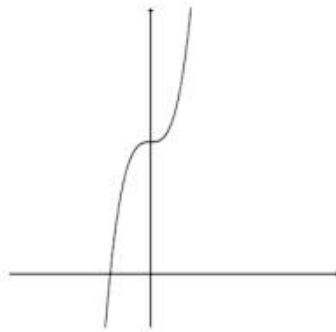
(a) attempt to form composite (in any order)

eg $f(x^3), (2x+3)^3$

$$(f \circ g)(x) = 2x^3 + 3, 2(x)^3 + 3$$

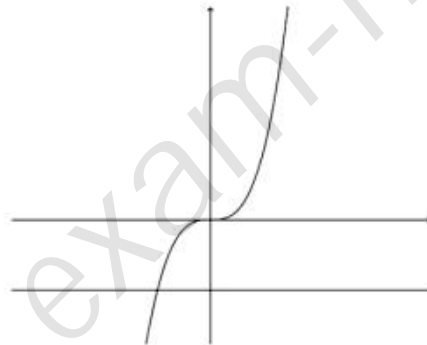
(b) evidence of appropriate approach

eg $2x^3 = -3$, sketch



correct working

eg $x^3 = \frac{-3}{2}$, sketch



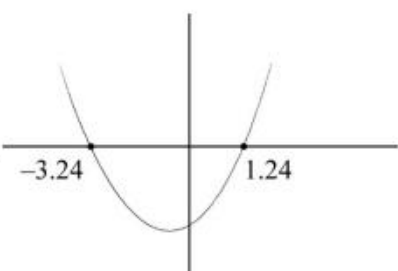
-1.14471

$$x = \sqrt[3]{\frac{-3}{2}} \text{ (exact), } -1.14 \text{ } [-1.15, -1.14]$$

3 - (MAT/21_SL_Summer_2015_Q4) - Functions - Roots

- (a) (i) valid approach
eg sketch, $f(x) = 0$, $0 = 2x - 6$
 $x = 3$ or $(3, 0)$
- (ii) $x = 1$ (must be equation)
- (iii) valid approach
eg sketch, $\frac{2x}{-1x}$, inputting large values of x , L'Hopital's rule
 $y = -2$ (must be equation)
- (b) valid approach
eg recognizing that $\lim_{x \rightarrow \infty}$ is related to the horizontal asymptote,
table with large values of x , their y value from (a)(iii), L'Hopital's rule
 $\lim_{x \rightarrow \infty} f(x) = -2$

4 - (MAT/20_SL_Winter_2016_Q1) - Functions - Roots

- (a) attempt to substitute $x = 8$ (M1)
eg $8^2 + 2 \times 8 + 1$ A1 N2
 $f(8) = 81$ [2 marks]
- (b) attempt to form composition (in any order) (M1)
eg $f(x-5)$, $g(f(x))$, $(x^2 + 2x + 1) - 5$
 $(g \circ f)(x) = x^2 + 2x - 4$ A1 N2
[2 marks]
- (c) valid approach (M1)
- eg $x = \frac{-2 \pm \sqrt{20}}{2}$, 
- 1.23606, -3.23606
- $x = 1.24$, $x = -3.24$ A1A1 N3
[3 marks]

5 - (MAT/21_SL_Summer_2014_Q10) - Functions - Roots, Differentiation

(a) $x = q, y = 3$ (must be equations)

(b) recognizing connection between point of intersection and asymptote

eg $x = 1$

$q = 1$

(c) correct substitution into distance formula

eg $\sqrt{(x-1)^2 + (y-3)^2}$

attempt to substitute $y = \frac{3x}{x-1}$

eg $\sqrt{(x-1)^2 + \left(\frac{3x}{x-1} - 3\right)^2}$

correct simplification of $\left(\frac{3x}{x-1} - 3\right)$

eg $\frac{3x - 3(x-1)}{x-1}$

correct expression clearly leading to the required answer

eg $\frac{3x - 3x + 3}{x-1}, \sqrt{(x-1)^2 + \left(\frac{3x - 3x + 3}{x-1}\right)^2}$

$PQ = \sqrt{(x-1)^2 + \left(\frac{3}{x-1}\right)^2}$

(d) recognizing that closest is when PQ is a minimum

eg sketch of PQ, $(PQ)'(x) = 0$

$x = -0.73205$ $x = 2.73205$ (seen anywhere)

attempt to find y-coordinates

eg $f(-0.73205)$

$(-0.73205, 1.267949), (2.73205, 4.73205)$

$(-0.732, 1.27), (2.73, 4.73)$