A-LEVEL MATHS (EDEXCEL 9MA0) · PURE YEAR 2 · CHAPTER 2: FUNCTIONS AND GRAPHS · A* EXAM PRACTICE

Hints online, answers free with an account:
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Functions and graphs: A* questions

75 marks

Date

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X A* exam questions

A to A*

Extended Edexcel-style questions. Show every step. The hints are at the end of the sheet. Use one at a time.

X1 The function f is defined by $f(x) = 2x^2 - 8x + 5$, $x \geq 2$.

(a) Find $f^{-1}(x)$, stating its domain and its range. [3 marks]

Answer $f^{-1}(x) = \ldots$

(b) Solve the equation $f(x) = f^{-1}(x)$. Give your answer in exact form. [4 marks]

Answer $x = \ldots$

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(c) The function g is defined by $g(x) = \dfrac{3}{x-1}$, $x > 1$. Explain why $gf(x)$ is not defined for every x in the domain of f, and find the set of values of x, with $x \geq 2$, for which $gf(x)$ is defined. [3 marks]

Answer ...

(d) Solve $gf(x) = 3$. [3 marks]

Answer $x = \ldots$

Total for X1: 13 marks

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X2 Find the set of values of k for which the equation $|2x - 3| = kx + 1$ has exactly one solution. [9 marks]

Answer ...

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X3 The function f is defined by $f(x) = \dfrac{2x+1}{x-2}$, $x > 2$.

(a) Show that $ff(x) = x$, and hence write down $f^{-1}(x)$. [3 marks]

(b) The function g is defined by $g(x) = \dfrac{px+7}{x+r}$, where p and r are constants. Given that $gg(x) = x$ for all x in the domain of g, prove that $r = -p$. [4 marks]

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(c) Find the range of f, and solve $f(x) = x$. Give your answer in exact form. [4 marks]

Answer range: ... ; $x = \ldots$

Total for X3: 11 marks

X4 The function f is defined by $f(x) = 2|x + 1| - 4$, $x \in \mathbb{R}$.

(a) Sketch the graph of $y = f(x)$. Give the coordinates of its vertex and of the points where it meets the axes. [3 marks]

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(b) Solve $|f(x)| = 2$. [4 marks]

Answer $x = \ldots$

(c) Find the coordinates of the vertex of $y = 3f\left(-\frac{x}{2}\right)$ and of the points where this graph meets the x-axis. [3 marks]

Answer vertex $\ldots$; $\ldots$

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(d) Find the set of values of k for which $|f(x)| = k$ has exactly four solutions. [2 marks]

Answer ...

Total for X4: 12 marks

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X5 The function f is defined by $f(x) = e^{2x} - 4e^{x} + 7$, $x \geq a$, where a is the smallest value for which f is one-to-one. Find the value of a and $f^{-1}(x)$, stating the domain of f^{-1}. Hence solve $f(x) = 12$. [9 marks]

Answer $a = \ldots$; $f^{-1}(x) = \ldots$; $x = \ldots$

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X6 A depot is to be built on a straight road. Three customers are on the road at 0 km, 6 km and 10 km from a junction. A van drives from the depot to each customer separately. The model for the total distance driven out, in km, when the depot is at position x km is

$$D(x) = |x| + |x - 6| + |x - 10|.$$

(a) Write $D(x)$ without modulus signs on each of the four intervals of x, and hence find the position of the depot that makes $D(x)$ as small as possible, and the least value. [4 marks]

Answer $x = \ldots$, $D = \ldots$

(b) Solve $D(x) = 14$. [4 marks]

Answer $x = \ldots$

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(c) A fourth customer is added at 14 km. Find the set of positions of the depot that make the total distance as small as possible, and the least total distance. [3 marks]

Answer ...

(d) Give one criticism of the model. [2 marks]

Total for X6: 13 marks

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X7 The functions f and g are defined by $f(x) = 3x - 2$, $x \in \mathbb{R}$, and $g(x) = x^2 + c$, $x \geq 0$, where c is a constant. Find the set of values of c for which the equation $fg(x) = gf(x)$ has two distinct solutions. [8 marks]

Answer ...

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F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can find how many solutions a modulus equation has as a parameter changes.	○	○	○
I can find an inverse function and use domains and ranges to reject answers.	○	○	○
I can decide where a composite function is defined and use that in an equation.	○	○	○
I can model a situation with modulus functions and criticise the model.	○	○	○

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Hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

X1

Hint 1 Complete the square on $f(x)$. The domain $x \geq 2$ decides which square root to keep.

Hint 2 On this domain f is increasing, so $y = f(x)$ and $y = f^{-1}(x)$ meet on the line $y = x$. Check each root is in the domain.

Hint 3 $gf(x)$ needs $f(x)$ to be in the domain of g, so $f(x) > 1$.

X2

Hint 1 Sketch $y = |2x - 3|$ and a line through $(0, 1)$. Turn the line about $(0, 1)$ and count crossings.

Hint 2 Solve each case for x in terms of k. A case only counts if its x is on its own side of $x = \frac{3}{2}$.

Hint 3 The line through the vertex $\left(\frac{3}{2}, 0\right)$ is a special case: both branches give the same point.

X3

Hint 1 Put $f(x)$ in place of x in f, then multiply the top and bottom by $x - 2$.

Hint 2 Work out $gg(x)$ in the same way and set it equal to x. Two expressions in x are equal for all x only if their coefficients match.

Hint 3 Divide $2x + 1$ by $x - 2$ to write $f(x) = 2 + \frac{5}{x - 2}$.

X4

Hint 1 f is $y = |x|$ moved left 1, stretched by 2 vertically and moved down 4.

Hint 2 $|f(x)| = 2$ means $f(x) = 2$ or $f(x) = -2$, and each of those has two solutions.

Hint 3 For $3f\left(-\frac{x}{2}\right)$, ask which x makes the input $-\frac{x}{2}$ equal to the special values -1, -3 and 1 of f.

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X5

Hint 1 Let $u = e^x$. Then $f(x) = u^2 - 4u + 7$. Complete the square.

Hint 2 f is one-to-one from its minimum point onwards. Which x gives $e^x = 2$?

Hint 3 On this domain $e^x - 2 \geq 0$, so take the positive square root when you rearrange. The range of f is the domain of f^{-1}.

X6

Hint 1 On each interval decide whether each bracket is positive or negative. The three critical values, where x, $x - 6$ and $x - 10$ change sign, split the line into four intervals.

Hint 2 Solve the equation on each interval, then keep an answer only if it lies in that interval.

Hint 3 Pair the customers: $|x| + |x - 14|$ is constant between 0 and 14, and $|x - 6| + |x - 10|$ is constant between 6 and 10.

X7

Hint 1 Write $fg(x)$ and $gf(x)$, set them equal and simplify to a quadratic.

Hint 2 $gf(x)$ only exists when $f(x)$ is in the domain of g. What does that say about x?

Hint 3 Find the two roots in terms of c. Both must lie in the domain you found.

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