EDEXCEL A-LEVEL MATHEMATICS (9MA0) · PURE PAPERS 1 AND 2 · A-LEVEL PURE A* REVISION · SHEET 2 OF 10

Hints online, answers free with an account:
mathswariz.uk/worksheets/a-level-pure-a-star-revision-2/

A-Level Pure A* revision 2

105 marks

Date

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X Exam questions

Edexcel 9MA0 Pure style, later parts of long questions. Show all your working: an answer with no method may score no marks. The hints are at the end of the sheet. Use one at a time.

X1 Solve, for $0 < x < 2\pi$, the equation [7 marks]

$$2\cot^2 x - 5\operatorname{cosec} x = 10$$

giving your answers in radians to 3 significant figures. Solutions relying entirely on calculator technology are not acceptable.

Answer .....

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X2 The curve C has equation [7 marks]

$$x^2 + 4xy + y^2 + 12 = 0$$

Find the exact coordinates of the points on C at which the tangent is parallel to the line $y = x$.

Answer .....

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X3 A student writes this proof that there are infinitely many prime numbers.

"Assume there are finitely many primes, $p_1, p_2, \ldots, p_n$.
Let $N = p_1 p_2 \ldots p_n + 1$.
N is not divisible by any of $p_1, \ldots, p_n$, so N is a new prime number.
This is a contradiction, so there are infinitely many primes."

(a) Given that $2 \times 3 \times 5 \times 7 \times 11 \times 13 + 1 = 30\,031 = 59 \times 509$, explain the error in the student's proof. [2 marks]

Answer .....

(b) Write out a correct proof by contradiction that there are infinitely many prime numbers. [5 marks]

Answer .....

Total for X3: 7 marks

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X4 A sequence $u_1, u_2, u_3, \ldots$ is defined by

$$u_1 = 2, \qquad u_{n+1} = \frac{u_n - 3}{u_n + 1}$$

(a) Find u_2, u_3 and u_4, and hence state the order of this periodic sequence. [3 marks]

Answer .....

(b) Find $\sum_{r=1}^{100} u_r$ [3 marks]

Answer .....

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(c) Find $\sum_{r=10}^{60} u_r$

[2 marks]

Answer .....

Total for X4: 8 marks

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X5 The points A, B and C have coordinates $(2, -1, 3)$, $(6, 1, 7)$ and $(8, 7, 4)$ respectively. $ABCD$ is a parallelogram. [8 marks]

Find the coordinates of D and the exact area of the parallelogram.

Answer .....

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X6

$$g(x) = \frac{10x^2 + 4x + 4}{(1 - x)(1 + 2x)^2}$$

(a) Express $g(x)$ in the form $\frac{A}{1 - x} + \frac{B}{1 + 2x} + \frac{C}{(1 + 2x)^2}$, where A, B and C are constants to be found. [4 marks]

Answer .....

(b) Hence find the binomial expansion of $g(x)$, in ascending powers of x, up to and including the term in x^2. [4 marks]

Answer .....

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(c) State the set of values of x for which this expansion is valid. [1 mark]

Answer .....

Total for X6: 9 marks

X7

$$f(x) = x^3 - 3x - 5$$

The equation $f(x) = 0$ has exactly one real root, α.

(a) Show that α lies in the interval $[2.2, 2.3]$. [2 marks]

Answer .....

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(b) Taking $x_1 = 2.3$ as a first approximation, apply the Newton-Raphson method once to find a second approximation to α. Give your answer to 5 decimal places. [3 marks]

Answer .....

(c) Explain why $x_1 = 1$ cannot be used as a first approximation in the Newton-Raphson method. [2 marks]

Answer .....

(d) With $x_1 = 0.9$, find x_2 to 2 decimal places. Comment on the suitability of $x_1 = 0.9$ as a first approximation to α. [2 marks]

Answer .....

Total for X7: 9 marks

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X8 The mass, m kg, and the length, l cm, of fish of one species are modelled by $m = pl^q$, where p and q are constants. Data were collected for fish with lengths between 16 cm and 63 cm. A graph of $\log_{10} m$ against $\log_{10} l$ is a straight line passing through the points $(1.2, -0.5)$ and $(1.8, 1.3)$.

(a) Find the value of q, and the value of p to 3 significant figures. [4 marks]

Answer .....

(b) Estimate the mass of a fish of length 50 cm. [2 marks]

Answer .....

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(c) Explain why the model should not be used to estimate the mass of a fish of length 2 m. [1 mark]

Answer .....

(d) According to the model, by what factor is the mass multiplied when the length of a fish doubles? Show your working. [2 marks]

Answer .....

Total for X8: 9 marks

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X9 The curve C has parametric equations

$$x = 3\sin t, \qquad y = 4\cos 2t, \qquad -\frac{\pi}{2} \leqslant t \leqslant \frac{\pi}{2}$$

(a) Find a Cartesian equation of C in the form $y = f(x)$, and state the domain of f. [4 marks]

Answer .....

(b) Find an equation of the tangent to C at the point where $t = \frac{\pi}{6}$ [4 marks]. Give your answer in the form $y = mx + c$.

Answer .....

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(c) The line $y = k$, where k is a constant, meets C at exactly two points. Find the set of possible values of k. [2 marks]

Answer .....

Total for X9: 10 marks

X10 In this question you must show all stages of your working.
Solutions relying entirely on calculator technology are not acceptable.

(a) Find $\int (\ln x)^2 \, dx$. [5 marks]

Answer .....

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(b) Hence find the exact area of the region bounded by the curve $y = (\ln x)^2$, the x-axis and the line $x = e$. [2 marks]

Answer .....

(c) The line $y = 1$ meets the curve $y = (\ln x)^2$ at two points. Find the exact area of the finite region bounded by the line and the curve. [3 marks]

Answer .....

Total for X10: 10 marks

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X11 The function f is defined by $f(x) = 3|x - 2| - 4$, $x \in \mathbb{R}$.

(a) Using algebra, solve the equation $3|x - 2| - 4 = 4x - 3$. [3 marks]

Answer .....

(b) Hence solve the inequality $3|x - 2| - 4 > 4x - 3$. [2 marks]

Answer .....

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(c) Find the set of values of k for which the equation $3|x-2|-4=kx-1$ has two distinct roots.
You must justify your answer. [5 marks]

Answer .....

Total for X11: 10 marks

X12 The number of fish in a lake, N thousand, at time t years after the lake was stocked is modelled by

$$\frac{dN}{dt}=\frac{N(8-N)}{16}, \qquad 0<N<8$$

When $t=0$, $N=2$.

(a) Express $\dfrac{16}{N(8-N)}$ in partial fractions. [2 marks]

Answer .....

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(b) Hence solve the differential equation to show that $N = \dfrac{8}{1 + 3e^{-\frac{1}{2}t}}$. [6 marks]

Answer .....

(c) Find the time at which the model predicts 6000 fish. Give your answer to 3 significant figures. [2 marks]

Answer .....

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(d) State the number of fish that the model predicts in the long term. [1 mark]

Answer .....

Total for X12: 11 marks

F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can write a complete proof: the assumption, each step with its reason, and a final conclusion.	○	○	○
I can find my own route through a question that has no parts, and give exact answers.	○	○	○
I can set up and solve a model in context, and say what the answer means and where the model stops working.	○	○	○
I can justify a result fully: a range of validity, a nature of a turning point, a root to a stated accuracy.	○	○	○

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Hints

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

X1	**Hint 1**	Use $1 + \cot^2 x = \operatorname{cosec}^2 x$ to write the equation in $\operatorname{cosec} x$ only.
	Hint 2	You should get a quadratic in $\operatorname{cosec} x$ with two roots. Both roots give solutions.
	Hint 3	Each value of $\sin x$ gives two angles between 0 and 2π. Where is sine negative?
X2	**Hint 1**	Differentiate every term with respect to x. The term $4xy$ needs the product rule.
	Hint 2	The line $y = x$ has gradient 1. Put $\dfrac{dy}{dx} = 1$, either in your formula or straight into the differentiated equation.
	Hint 3	You get a relation between x and y. Substitute it back into the equation of the curve, and pair each x with the correct y.
X3	**Hint 1**	For (a), read each line and ask "does this follow?". The numbers you are given show a product of primes plus 1 that is not prime.
	Hint 2	For (b), the product plus 1 leaves remainder 1 when divided by each prime in the list. Say what that tells you about its factors.
	Hint 3	Every integer greater than 1 is prime or has a prime factor. Deal with both cases, then say which assumption is contradicted.
X4	**Hint 1**	Substitute $u_1 = 2$ to get u_2, then use u_2 to get u_3, and so on, keeping exact fractions.
	Hint 2	For (b), find the sum of one complete cycle and count how many complete cycles there are in 100 terms.
	Hint 3	For (c), count the terms from $r = 10$ to $r = 60$ carefully: it is not 50.

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X5

Hint 1 In a parallelogram $ABCD$, the side AD is equal and parallel to BC.

Hint 2 The area is $AB \times BC \times \sin B$. Find the angle at B with the cosine rule, using the three sides of triangle ABC.

Hint 3 Keep $\cos B$ as a fraction and use $\sin^2 B = 1 - \cos^2 B$ to get an exact value.

X6

Hint 1 For (a), multiply through by $(1-x)(1+2x)^2$. Two values of x give A and C at once; compare coefficients of x^2 for B.

Hint 2 For (b), the third fraction has index -2. Its x^2 term is $\dfrac{(-2)(-3)}{2!}(2x)^2$.

Hint 3 Check your constant term: it should equal $g(0)$.

X7

Hint 1 Newton-Raphson: $x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)}$.

Hint 2 For (c), work out $f'(1)$ and look at what the formula asks you to do with it.

Hint 3 For (d), a small value of $f'(x_1)$ means a large step. Say what this does to x_2.

X8

Hint 1 Take logarithms of both sides of $m = pl^q$. Which constant is the gradient?

Hint 2 The line does not pass through a point with $\log_{10} l = 0$, so find the intercept from $y = mx + c$.

Hint 3 For (d), replace l with $2l$ in the model and divide by the original.

X9

Hint 1 y contains $\cos 2t$ and x contains $\sin t$. Which form of $\cos 2t$ uses only $\sin t$?

Hint 2 The domain is not all real x: it comes from the values $3 \sin t$ can take.

Hint 3 For (c), sketch the curve with its end points. At $k = 4$ how many points are there? At $k = -4$?

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X10

Hint 1 There is only one function, so write the integrand as $1 \times (\ln x)^2$ and differentiate $(\ln x)^2$.

Hint 2 After the first step you need $\int \ln x \, dx$. That needs integration by parts again.

Hint 3 For (c), $\ln x = -1$ is a solution too. At $x = \dfrac{1}{e}$, $\ln x = -1$, so take care with the signs.

X11

Hint 1 For (a), solve once with $|x - 2| = x - 2$ and once with $|x - 2| = -(x - 2)$. Each answer is only valid in its own region.

Hint 2 For (c), sketch the V: where is its vertex? Every line $y = kx - 1$ passes through the same point on the y-axis.

Hint 3 Rotate the line about $(0, -1)$. It must go above the vertex and it must not be parallel to (or steeper than) the right-hand arm.

X12

Hint 1 Separate the variables so that $\dfrac{16}{N(8 - N)}$ is on the side with dN.

Hint 2 Integrating $\dfrac{2}{8 - N}$ gives $-2\ln(8 - N)$. Find the constant before you rearrange.

Hint 3 To reach the given form, get all the terms in N on one side, factorise, then divide top and bottom by $e^{\frac{1}{2}t}$.

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