EDEXCEL A-LEVEL MATHEMATICS (9MA0) · PURE PAPERS 1 AND 2 · A-LEVEL PURE A* REVISION · SHEET 5 OF 10

Hints online, answers free with an account:
mathswariz.uk/worksheets/a-level-pure-a-star-revision-5/

A-Level Pure A* revision 5

104 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 The circle C has equation $x^2 + y^2 - 10x - 6y + 29 = 0$. [7 marks]
The line l has equation $y = kx - 2$, where k is a constant.

Find the range of values of k for which l meets C at two distinct points.
Solutions relying entirely on calculator technology are not acceptable.

Answer .....

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X2 In this question you must show all stages of your working.
Solutions relying entirely on calculator technology are not acceptable.

(a) Find the set of values of x for which [5 marks]

$$|3x - 4| < 2|x + 1|$$

Give your answer in set notation.

Answer .....

(b) Hence find the exact set of values of t for which $|3e^t - 4| < 2e^t + 2$. [2 marks]

Answer .....

Total for X2: 7 marks

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X3 The curve C has parametric equations [8 marks]

$$x = 3t^2, \qquad y = t^3, \qquad t \in \mathbb{R}$$

The tangent to C at the point P passes through the point $A(7, 3)$.

Find the coordinates of each of the possible positions of P.
Solutions relying entirely on calculator technology are not acceptable.

Answer .....

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X4 For each statement below, decide whether it is true or false.
If it is true, prove it. If it is false, give a counter-example.

(a) "If p and q are irrational numbers, then pq is irrational." [2 marks]

Answer .....

(b) "$n^2 - n + 11$ is a prime number for every positive integer n." [2 marks]

Answer .....

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(c) "For all positive real numbers x and y, $(x+y)\left(\frac{1}{x}+\frac{1}{y}\right) \geqslant 4$ [4 marks]

."

Answer .....

Total for X4: 8 marks

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X5 In the binomial expansion of $(1 + ax)^n$, where a and n are constants, the first three terms in ascending powers of x are

$$1 - 6x + 27x^2$$

(a) Find the value of a and the value of n. [5 marks]

Answer .....

(b) Find the coefficient of x^3 in the expansion. [2 marks]

Answer .....

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

Answer .....

Total for X5: 8 marks

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X6 A poster has a rectangular printed region of area 600 cm². The printed region is surrounded by blank margins: 4 cm at the top, 4 cm at the bottom and 3 cm at each side. [9 marks]

Find the least possible total area of the poster, giving your answer in the form $a + b\sqrt{2}$, where a and b are integers. You must show that your answer is a minimum.

Answer .....

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X7 A ball of ice is modelled as a sphere of radius r cm at time t minutes. The ice melts so that the rate of decrease of its volume is proportional to its surface area.
[The volume of a sphere is $\frac{4}{3}\pi r^3$ and its surface area is $4\pi r^2$.]

(a) Show that $\frac{dr}{dt} = -k$, where k is a positive constant. [3 marks]

Answer .....

(b) Initially the radius is 6 cm, and after 20 minutes the radius is 5 cm. Find r in terms of t. [2 marks]

Answer .....

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(c) Find the time at which the volume of the ball is half its initial volume. Give your answer to 3 significant figures. [3 marks]

Answer .....

(d) State one limitation of the model. [1 mark]

Answer .....

Total for X7: 9 marks

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X8 A circular lawn has centre O and radius r metres. A straight path joins two points A and B on the edge of the lawn. The path cuts off a minor segment whose area is one fifth of the area of the lawn. Angle $AOB = \theta$ radians.

(a) Show that $\theta - \sin\theta = \dfrac{2\pi}{5}$. [3 marks]

Answer .....

(b) Show that the equation in part (a) has a root in the interval $[2.11, 2.12]$. [2 marks]

Answer .....

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(c) Use the iteration $\theta_{n+1} = \dfrac{2\pi}{5} + \sin\theta_n$ with $\theta_1 = 2.1$ to find θ_2, θ_3 and θ_4 to 4 decimal places. [3 marks]

Answer .....

(d) Describe the way in which these values approach the root. [1 mark]

Answer .....

Total for X8: 9 marks

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X9 The number of subscribers, N, to a video channel t weeks after it was launched is modelled by $N = ae^{kt}$, where a and k are constants. There were 148 subscribers when $t = 2$ and 485 subscribers when $t = 9$.

(a) Find the value of k to 3 significant figures, and the value of a to the nearest whole number. [4 marks]

Answer .....

(b) When $t = 5$ there were 240 subscribers. Comment on the suitability of the model. [2 marks]

Answer .....

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(c) Find the value of t at which the model predicts 1000 subscribers. Give your answer to 3 significant figures. [2 marks]

Answer .....

(d) Give one limitation of the model. [1 mark]

Answer .....

Total for X9: 9 marks

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X10 The finite region R is bounded by the curve $y = x \ln x$, the x-axis and the line $x = 3$.

(a) Use the trapezium rule with 4 strips of equal width to find an estimate for the area of R. Give your answer to 3 decimal places. [3 marks]

Answer .....

(b) Use integration by parts to find the exact area of R. [4 marks]

Answer .....

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(c) Without using your answer to (b), explain, with a reason based on $\frac{d^2y}{dx^2}$, whether the answer to (a) is an overestimate or an underestimate. [2 marks]

Answer .....

(d) State one change to the method in (a) that would give a more accurate estimate. [1 mark]

Answer .....

Total for X10: 10 marks

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X11 Kofi is offered a job with a starting salary of $£24\,000$ in year 1. He can choose one of two pay schemes.

Scheme A: the salary increases by $£900$ each year.
Scheme B: the salary increases by 3% each year.

(a) Find the total amount Kofi would earn in the first 10 years under Scheme A. [2 marks]

Answer .....

(b) Show that year 17 is the first year in which the salary under Scheme B is greater than the salary under Scheme A. [3 marks]

Answer .....

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(c) Under Scheme B, find the least number of complete years N for which the total amount earned is more than $£1\,000\,000$. Solutions relying entirely on calculator technology are not acceptable. [4 marks]

Answer .....

(d) Give one reason why Scheme B may not be a suitable model for Kofi's salary over 28 years. [1 mark]

Answer .....

Total for X11: 10 marks

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X12 In this question you must show all stages of your working.

(a) Prove that [3 marks]

$$\frac{1-\cos 2x}{1+\cos 2x} \equiv \sec^2 x - 1, \quad x \neq \frac{(2n+1)\pi}{2}$$

Answer .....

(b) Hence solve, for $0 \leqslant x < 2\pi$, [5 marks]

$$\frac{1-\cos 2x}{1+\cos 2x} = 2\sec x + 2$$

Give exact answers where possible, and other answers to 3 significant figures.

Answer .....

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(c) Explain why the equation $\dfrac{1-\cos 2x}{1+\cos 2x} = -2$ has no solutions. [2 marks]

Answer .....

Total for X12: 10 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 Substitute the line into the circle to get a quadratic in x whose coefficients contain k.

Hint 2 Two distinct points of intersection means the quadratic has two distinct real roots.

Hint 3 You will get a quadratic inequality in k. Take care with the direction of the inequality when you divide by a negative number.

X2

Hint 1 Both sides of the inequality are never negative, so you may square them. Or find where $3x - 4 = 2(x + 1)$ and where $3x - 4 = -2(x + 1)$.

Hint 2 Once you have the two critical values, decide between "inside" and "outside" by testing a value such as $x = 1$.

Hint 3 For (b), compare it with (a): which expression has taken the place of x? Why is $2e^t + 2$ the same as $2|e^t + 1|$?

X3

Hint 1 Do not use a particular value of t. Write the equation of the tangent at the point $(3t^2, t^3)$ in terms of t.

Hint 2 The tangent passes through A, so $x = 7$, $y = 3$ satisfies its equation. This gives an equation in t.

Hint 3 You should get a cubic in t. Try small whole numbers to find a first root, then factorise.

X4

Hint 1 A counter-example is one specific case, worked out, followed by a sentence saying the statement is false.

Hint 2 For (b), look for a value of n that makes every term a multiple of the same number.

Hint 3 For (c), expand the brackets. Then start from something that is certainly true, $(x - y)^2 \geqslant 0$, and work towards the result. Say why you may divide by xy.

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X5

Hint 1 Write the general expansion $1 + nax + \frac{n(n-1)}{2}a^2x^2 + \dots$ and compare coefficients.

Hint 2 Square the equation $na = -6$ and divide it into the other equation to remove a.

Hint 3 n is not a positive integer here, so the expansion has a range of validity. It depends on ax.

X6

Hint 1 Choose a letter for the width of the printed region. Write its height, then the full width and full height of the poster.

Hint 2 Expand the total area into the form constant $+ pw + \frac{q}{w}$ before you differentiate.

Hint 3 After finding the stationary value, use the second derivative to show it is a minimum.

X7

Hint 1 Write the statement as $\frac{dV}{dt} = -k\times$ (surface area). Then connect $\frac{dV}{dt}$ and $\frac{dr}{dt}$ with the chain rule.

Hint 2 A constant rate of change means r is a linear function of t.

Hint 3 Half the volume does not mean half the radius. Volume is proportional to r^3.

X8

Hint 1 A segment is a sector with a triangle taken away. The triangle has area $\frac{1}{2}r^2\sin\theta$.

Hint 2 The area of the whole lawn is πr^2. The r^2 cancels.

Hint 3 Compare each of θ_2, θ_3, θ_4 with the interval found in part (b).

X9

Hint 1 Write one equation for each data point, then divide one by the other.

Hint 2 Keep unrounded values of a and k in your calculator for the later parts.

Hint 3 For (b), a comment needs a number from the model, a comparison and a conclusion.

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X10

Hint 1 First find where the curve meets the x-axis. That is the lower limit, and it fixes the strip width.

Hint 2 For (b), differentiate $\ln x$ and integrate x.

Hint 3 For (c), the sign of $\dfrac{d^2y}{dx^2}$ tells you which way the curve bends. Compare the curve with the straight tops of the trapezia.

X11

Hint 1 Scheme A is an arithmetic sequence and Scheme B is a geometric sequence. Write the salary in year n for each.

Hint 2 For (b), "first" needs two years compared: the year before, where B is still lower, and year 17, where B is higher.

Hint 3 For (c), use the sum of a geometric series and take logarithms to find N.

X12

Hint 1 There are three forms of $\cos 2x$. Pick one that cancels the 1 on the top and a different one that cancels the 1 on the bottom.

Hint 2 For (b), replace the left-hand side using (a). You get a quadratic in $\sec x$.

Hint 3 Do not reject $\sec x = -1$. Which angle has $\cos x = -1$?

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