A-LEVEL MATHS (EDEXCEL 9MA0) · PURE YEAR 2 · CHAPTER 5: RADIANS · A* EXAM PRACTICE

Hints online, answers free with an account:
mathswariz.uk/worksheets/a-level-pure-year-2-chapter-5-a-star/

Radians: A* questions

75 marks

Date

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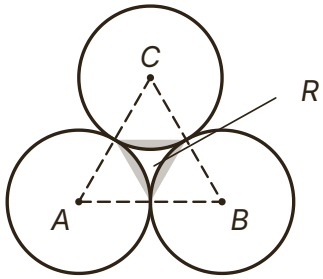
X A* exam questions

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 Three circles, each of radius 2 cm, have centres A, B and C. Each circle touches the other two, so ABC is an equilateral triangle. The shaded region R lies between the three circles.

(a) Show that the perimeter of R is 2π cm. [2 marks]



(b) Show that the area of R is $\left(4\sqrt{3} - 2\pi\right)$ cm². [3 marks]

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(c) A fourth circle lies inside R and touches all three circles. Find its radius, giving your answer in the form $\dfrac{a\sqrt{3}+b}{3}$ where a and b are integers. [3 marks]

Answer radius $=\ldots$ cm

(d) Find the percentage of the area of R that is covered by the fourth circle. Give your answer to 3 significant figures. [2 marks]

Answer $\ldots\%$

Total for X1: 10 marks

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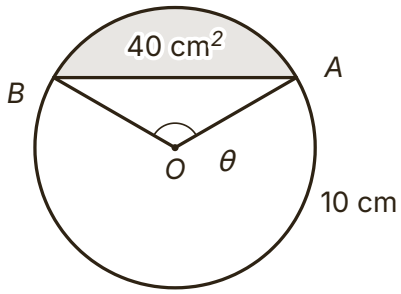
X2 The chord AB cuts a segment from a circle with centre O and radius 10 cm. Angle $AOB = \theta$ radians, where $0 < \theta < \pi$. The minor segment has area 40 cm². Show that θ lies between 1.7 and 1.8, find θ correct to 2 decimal places, and find the perimeter of the segment correct to 3 significant figures. [9 marks]



not to scale

Answer $\theta = \ldots$, perimeter $= \ldots$ cm

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X3 In this question x is in radians and $0 \leq x < 2\pi$. The equation $2\cos^2 x + 3\sin x = k$ has a constant k.

(a) Show that the equation can be written as $2\sin^2 x - 3\sin x + k - 2 = 0$. [2 marks]

(b) Solve the equation when $k = 3$. Give your answers as exact multiples of π. [4 marks]

Answer $x = \ldots$

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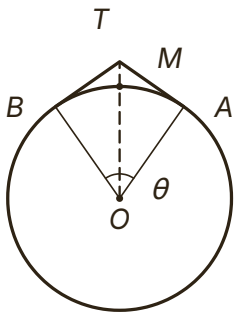
(c) Find the set of values of k for which the equation has exactly two solutions. [4 marks]

Answer ...

Total for X3: 10 marks

X4 A and B are points on a circle with centre O and radius 10 cm. Angle $AOB = \theta$ radians. The tangents to the circle at A and B meet at T. The line OT meets the circle at M, and $d = MT$.

(a) Show that $OT = \dfrac{10}{\cos\frac{\theta}{2}}$. [2 marks]



not to scale

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(b) Given that θ is small, show that $d \approx \frac{5}{4}\theta^2$. [3 marks]

(c) Use the approximation to estimate θ when $d = 0.2$ cm. [2 marks]

Answer $\theta \approx \ldots$

(d) Find the true value of θ when $d = 0.2$ cm. Give your answer to 3 significant figures. [2 marks]

Answer $\theta = \ldots$

Total for X4: 9 marks

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X5 The height, h metres, of a seat on a Ferris wheel above the ground t minutes after the ride starts is modelled by $h = 20 - 18\cos\left(\frac{\pi t}{10}\right)$, where the angle is in radians. Find how long the seat spends more than 29 m above the ground during each turn of the wheel. Give your answer in minutes and seconds. [8 marks]

Answer ... minutes ... seconds

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X6 A sector OAB of a circle has centre O, radius 12 cm and angle θ radians. The edges OA and OB are joined to make the curved surface of a cone, with no overlap. The cone has base radius R cm and volume V cm³.

(a) Show that $R = \dfrac{6\theta}{\pi}$. [2 marks]

(b) Show that $V = \dfrac{1}{3}\pi R^2\sqrt{144 - R^2}$. [2 marks]

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(c) Find the exact value of R for which V is greatest, and show that it gives a maximum. [4 marks]

Answer $R = \ldots$

(d) Find the angle θ of the sector that gives the greatest volume, and the greatest volume. Give your answers to 3 significant figures. [3 marks]

Answer $\theta = \ldots$, $V = \ldots$ cm³

Total for X6: 11 marks

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X7 In this question θ is in radians unless stated otherwise.

(a) Use small-angle approximations to show that, for small θ, $\dfrac{1-\cos 4\theta}{\theta \sin 2\theta} \approx 4$. [3 marks]

(b) Find the percentage error in this approximation when $\theta = 0.05$. Give your answer to 2 significant figures. [3 marks]

Answer ...%

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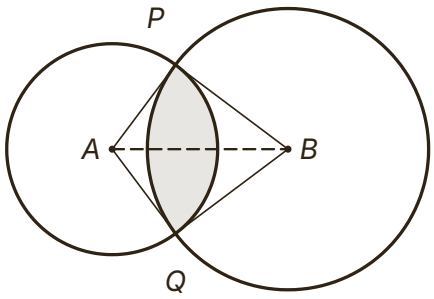
(c) Ben wants the value of the expression for an angle of $3°$. He writes $\theta = 3$ and says the answer is close to 4. Explain Ben's error, and find the value of the expression for $3°$ correct to 3 significant figures. [3 marks]

Answer ...

Total for X7: 9 marks

X8 Two circles have centres A and B, with $AB = 5$ cm. The circle with centre A has radius 3 cm and the circle with centre B has radius 4 cm. The circles meet at P and Q. The shaded region is inside both circles.

(a) Show that angle APB is a right angle, and that angle $PAB = 0.927$ radians to 3 decimal places. [2 marks]



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(b) Find the area of the shaded region. Give your answer to 3 significant figures. [5 marks]

Answer ... cm^2

(c) Find the perimeter of the shaded region. Give your answer to 3 significant figures. [2 marks]

Answer ... cm

Total for X8: 9 marks

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F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can find arcs, sectors and segments in shapes made from several circles.	○	○	○
I can solve a trigonometric equation in radians and count its solutions.	○	○	○
I can use small-angle approximations and find the percentage error.	○	○	○
I can solve problems that need radian measure with calculus or a 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 Each corner of an equilateral triangle is $\frac{\pi}{3}$ radians, and each arc of R belongs to a sector with that angle.

Hint 2 R is the triangle with three sectors taken away.

Hint 3 The fourth circle's centre is the same distance from A, B and C. Take 2 cm off that distance.

X2

Hint 1 The area of a segment is $\frac{1}{2}r^2(\theta - \sin\theta)$ with θ in radians.

Hint 2 Write $f(\theta) = \theta - \sin\theta - 0.8$ and look for a change of sign. To fix the second decimal place, test the two ends of the interval that rounds to it.

Hint 3 The perimeter is the arc plus the chord. The chord is $2r\sin\frac{\theta}{2}$.

X3

Hint 1 Use $\cos^2 x = 1 - \sin^2 x$.

Hint 2 Treat the equation as a quadratic in $\sin x$. Remember $\sin x = 1$ has only one solution in the range.

Hint 3 Sketch $k = -2s^2 + 3s + 2$ for $-1 \le s \le 1$. Count how many values of s give each k, then how many values of x each s gives.

X4

Hint 1 A tangent meets the radius at a right angle. Use triangle OAT.

Hint 2 Replace $\cos\frac{\theta}{2}$ by $1 - \frac{1}{2}\left(\frac{\theta}{2}\right)^2$, then expand $(1-u)^{-1}$.

Hint 3 For the true value, $OT = 10 + 0.2$.

X5

Hint 1 One turn ends when $\frac{\pi t}{10} = 2\pi$.

Hint 2 Rearrange to get $\cos\left(\frac{\pi t}{10}\right) < -\frac{1}{2}$.

Hint 3 Find both angles in $[0, 2\pi)$ with cosine $-\frac{1}{2}$, then the times between them.

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X6	**Hint 1**	The arc of the sector becomes the edge of the base of the cone.
	Hint 2	The radius of the sector becomes the slant height of the cone.
	Hint 3	V is greatest when V^2 is, and V^2 has no square root in it.
X7	**Hint 1**	Replace $\cos 4\theta$ by $1 - \dfrac{(4\theta)^2}{2}$ and $\sin 2\theta$ by 2θ.
	Hint 2	Work out the exact value with a calculator in radian mode.
	Hint 3	Convert 3° to radians before substituting.
X8	**Hint 1**	Compare $3^2 + 4^2$ with 5^2.
	Hint 2	The shaded region is two segments, one from each circle, both cut off by the chord PQ.
	Hint 3	Each arc is radius $\times$ angle at its own centre.

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