adamjee maths

A-LEVEL MATHS / EDEXCEL / FREE RESOURCES

Surds and indices

Mark scheme

2 questions

Exam questions and marking instructions remain credited to their board.

Contents

1 June 2025 - Paper 1 - Q2

2 October 2021 - Paper 1 - Q7

Question	Scheme	Marks	AOs
2 (a)	(i) Centre $(-3, 4)$	B1	1.1b
	(ii) States or implies that $r^2 = 24$ or $r = \sqrt{24}$	M1	1.1b
	$2\sqrt{6}$	A1	1.1b
		(3)	
(b)	Attempts a valid method e.g. Finds distance of centre from origin, Sets $y = 0$ and finds values of x	M1	3.1a
	Correct calculations, reason and conclusion (see notes)	A1	2.4
		(2)	
			(5 marks)

Notes:

Mark (i) and (ii) together

(a)(i)

B1: Centre $(-3, 4)$ Accept without brackets. May be written e.g. $x = -3,\ y = 4$

(a)(ii)

M1: States or implies that $r^2 = 24$ or $r = \sqrt{24}$. A final answer of $\sqrt{24}$ or $2\sqrt{6}$ implies the radius

May multiply out the brackets, collect terms ($x^2 + y^2 + 6x - 8y + 1 = 0$) and states the radius is $r^2 = \frac{6^2}{4} + \frac{(-8)^2}{4} - 1$ o.e. Do not condone slips for this mark.

A1: $2\sqrt{6}$ isw if they proceed to write as a decimal

(b) Note that if their radius is incorrect in (a) then maximum score is M1A0 unless they restart in (b)

M1: Attempts a valid method. For example

- Finds the distance (or distance ^{2}) of the centre from the origin.
  They must be attempting $(d =)\sqrt{(\pm"3")^2 + ("\pm"4")^2} = ...$ or
  $(d^2 =)(\pm"3" - 0)^2 + (\pm"4" - 0)^2 = ...$ and proceed to a value.
  May be seen as substituting the coordinates of the origin into the equation for C proceeding to a value for the left hand side e.g. 25 (to be able to compare with 24)
- Sets $y = 0$ and attempts to solve $(x+3)^2 + (-4)^2 = 24 \Rightarrow x = ...$ (at least one value)
- Sets $x = 0$ and attempts to solve $(3)^2 + (y-4)^2 = 24 \Rightarrow y = ...$ (at least one value)

In each method the starting expression or equation must be correct but do not be concerned by slips when evaluating or processing in finding the distance, the x coordinate or y coordinate.

Calculation examples	Reason examples	Conclusion examples
e.g. $\left(d^2 =\right) 25$ or e.g. $(d =) 5$	$25 > 24$ o.e. or $5 > \sqrt{24}$ o.e. (allow 4.9 or better)	e.g. origin does NOT lie within circle / origin lies outside circle / not in circle o.e.
e.g. $(x+3)^2 + (-4)^2 = 24$ $\Rightarrow (x =) -3 \pm \sqrt{8}$ (allow decimals awrt -0.2 and awrt -5.8)	roots are both negative (same signs) o.e.	
e.g. $(3)^2 + (y-4)^2 = 24$ $\Rightarrow (y =) 4 \pm \sqrt{15}$ (allow decimals awrt 0.1 and awrt 7.9)	roots are both positive (same signs) o.e.	

Note if their reasoning is incorrect e.g. referring to the radius as 24 instead of $\sqrt{24}$ then A0 but allow referencing to "the radius of *C*" provided their radius in (a) was correct.

Note if they give a reason that the origin does not lie inside the circle *C* because e.g. $25 \neq 24$ this scores M1A0 (M1 for 25 but A0 incorrect reasoning)

Question	Scheme	Marks	AOs

7(a)(i)	$(x-5)^2+(y+2)^2=...$	M1	1.1b
	$(5,-2)$	A1	1.1b
(ii)	$r=\sqrt{"5"^2+"-2"^2-11}$	M1	1.1b
	$r=3\sqrt{2}$	A1	1.1b
		(4)	
(b)	$y=3x+k \Rightarrow x^2+(3x+k)^2-10x+4(3x+k)+11=0$ $\Rightarrow x^2+9x^2+6kx+k^2-10x+12x+4k+11=0$	M1	2.1
	$\Rightarrow 10x^2+(6k+2)x+k^2+4k+11=0$	A1	1.1b
	$b^2-4ac=0 \Rightarrow (6k+2)^2-4\times10\times(k^2+4k+11)=0$	M1	3.1a
	$\Rightarrow 4k^2+136k+436=0 \Rightarrow k=...$	M1	1.1b
	$k=-17\pm6\sqrt{5}$	A1	2.2a
		(5)	
			(9 marks)

Notes

(a)(i)

M1: Attempts to complete the square on by halving both x and y terms.

Award for sight of $(x\pm5)^2,(y\pm2)^2=...$ This mark can be implied by a centre of (±5, ±2).

A1: Correct coordinates. (Allow $x = 5$, $y = -2$)

(a)(ii)

M1: Correct strategy for the radius or radius^2 . For example award for $r=\sqrt{"\pm5"^2+"\pm2"^2-11}$

or an attempt such as $(x-a)^2-a^2+(y-b)^2-b^2+11=0 \Rightarrow (x-a)^2+(y-b)^2=k \Rightarrow r^2=k$

A1: $r=3\sqrt{2}$. Do not accept for the A1 either $r=\pm3\sqrt{2}$ or $\sqrt{18}$

The A1 can be awarded following sign slips on $(5,-2)$ so following $r^2="\pm5"^2+"\pm2"^2-11$

(b) Main method seen

M1: Substitutes $y = 3x + k$ into the given equation (or their factorised version) and makes progress by attempting to expand the brackets. Condone lack of = 0

A1: Correct 3 term quadratic equation.

The terms must be collected but this can be implied by correct a, b and c

M1: Recognises the requirement to use $b^2 – 4ac = 0$ (or equivalent) where both b and c are expressions in k . It is dependent upon having attempted to substitute $y = 3x + k$ into the given equation

M1: Solves 3TQ in k. See General Principles.

The 3TQ in k must have been found as a result of attempt at $b^2 – 4ac$ ... 0

A1: Correct simplified values

Look carefully at the method used. It is possible to attempt this using gradients

(b) Alt 1	$x^2+y^2-10x+4y+11=0 \Rightarrow 2x+2y\frac{dy}{dx}-10+4\frac{dy}{dx}=0$	M1 A1	2.1 1.1b
	Sets $\frac{dy}{dx}=3 \Rightarrow x+3y+1=0$ and combines with equation for C $\Rightarrow 5x^2-50x+44=0$ or $5y^2+20y+11=0$ $\Rightarrow x=...$ or $y=...$	M1	3.1a
	$x=\frac{25\pm9\sqrt{5}}{5}$, $y=\frac{-10\pm3\sqrt{5}}{5}$, $k=y-3x \Rightarrow k=...$	M1	1.1b
	$k=-17\pm6\sqrt{5}$	A1	2.2a

M1: Differentiates implicitly condoning slips but must have two $\frac{dy}{dx}$'s coming from correct terms

A1: Correct differentiation.

M1: Sets $\frac{dy}{dx} = 3$, makes y or x the subject, substitutes back into C and attempts to solve the resulting quadratic in x or y.

M1: Uses at least one pair of coordinates and l to find at least one value for k. It is dependent upon having attempted both M's

A1: Correct simplified values

(b) Alt 2	$x^2 + y^2 - 10x + 4y + 11 = 0 \Rightarrow 2x + 2y\frac{dy}{dx} - 10 + 4\frac{dy}{dx} = 0$	M1 A1	2.1 1.1b
	Sets $\frac{dy}{dx} = 3 \Rightarrow x + 3y + 1 = 0$ and combines with equation for l $y = 3x + k, x + 3y = 1$ $\Rightarrow x = ...$ and $y = ...$ in terms of k	M1	3.1a
	$x = \frac{-3k-1}{10}, \ y = \frac{k-3}{10}, \ x^2 + y^2 - 10x + 4y + 11 = 0 \Rightarrow k = ...$	M1	1.1b
	$k = -17 \pm 6\sqrt{5}$	A1	2.2a

Very similar except it uses equation for l instead of C in mark 3

M1 A1: Correct differentiation (See alt 1)

M1: Sets $\frac{dy}{dx} = 3$, makes y or x the subject, substitutes back into l to obtain x and y in terms of k

M1: Substitutes for x and y into C and solves resulting 3TQ in k

A1: Correct simplified values

(b) Alt 3	$y = 3x + k \Rightarrow m = 3 \Rightarrow m_r = -\frac{1}{3}$	M1
	$y + 2 = -\frac{1}{3}(x - 5)$	A1
	$(x-5)^2 + (y+2)^2 = 18, \ y + 2 = -\frac{1}{3}(x-5)$ $\Rightarrow \frac{10}{9}(x-5)^2 = 18 \Rightarrow x = ...$ or $\Rightarrow 10(y+2)^2 = 18 \Rightarrow y = ...$	M1
	$x = \frac{25 \pm 9\sqrt{5}}{5}, \ y = \frac{-10 \pm 3\sqrt{5}}{5}, \ k = y - 3x \Rightarrow k = ...$	M1
	$k = -17 \pm 6\sqrt{5}$	A1

M1: Applies negative reciprocal rule to obtain gradient of radius

A1: Correct equation of radial line passing through the centre of C

M1: Solves simultaneously to find x or y

Alternatively solves "$y = -\frac{1}{3}x - \frac{1}{3}$" and $y = 3x + k$ to get x in terms of k which they substitute in $x^2 + (3x + k)^2 - 10x + 4(3x + k) + 11 = 0$ to form an equation in k.

M1: Applies $k = y - 3x$ with at least one pair of values to find k

A1: Correct simplified values