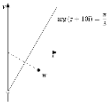
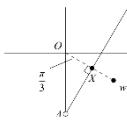
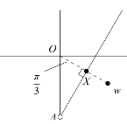


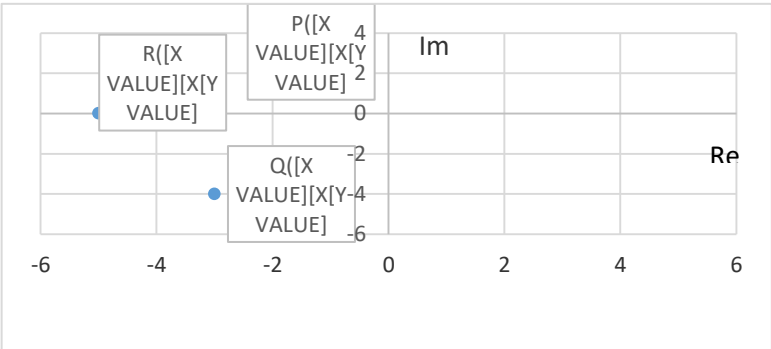
Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

1(a)	$ w = \sqrt{(4\sqrt{3})^2 + (-4)^2} = 8$	B1	1.1b	
	$\arg w = \arctan\left(\frac{\pm 4}{4\sqrt{3}}\right) = \arctan\left(\pm \frac{1}{\sqrt{3}}\right)$	M1	1.1b	
	$= -\frac{\pi}{6}$	A1	1.1b	
	So $(w =) 8\left(\cos\left(-\frac{\pi}{6}\right) + i\sin\left(-\frac{\pi}{6}\right)\right)$	A1	1.1b	
		(4)		
(b)		(i) w in 4 th quadrant with either $(4\sqrt{3}, -4)$ seen or $-\frac{\pi}{4} < \arg w < 0$	B1	1.1b
		(ii) half line with positive gradient emanating from imaginary axis.	M1	1.1b
		The half line should pass between O and w starting from a point on the imaginary axis below w	A1	1.1b
			(3)	
(c)		$\triangle OAX$ is right angled at X so $OX = 10 \sin \frac{\pi}{6} = 5$ (oe)	M1	3.1a
		So shortest distance is $WX = OW - OX = '8' - 5 = \dots$	M1	1.1b
		So min distance is 3	A1	1.1b
	<p>Alternative 1</p> 	A complete method to find the coordinates of X . Finds the equation of the line from O to w , $y = -\frac{1}{\sqrt{3}}x$ and the equation of the half line $y = \sqrt{3}x - 10$, solves to find the point of intersection $X \left(\frac{5\sqrt{3}}{2}, -\frac{5}{2}\right)$	M1	3.1a
		Finds the length WX	M1	1.1b

Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

		$\sqrt{\left(4\sqrt{3} - \frac{5\sqrt{3}}{2}\right)^2 + \left(-4 - \frac{5}{2}\right)^2}$		
		So min distance is 3	A1	1.1b

Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

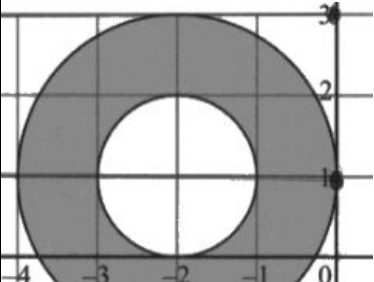
<p>2(a)</p>	<p>$z^2 = (a + 2i)(a + 2i) = (a^2 - 4) + 4ia$ So $z^2 + 2z = (a^2 - 4 + 2a) + i(4a + 4)$ or $x = (a^2 + 2a - 4)$ and $y = 4a + 4$</p>	<p>M1M1 A1A1 (4)</p>
<p>2(b)</p>	<p>and so $4a + 4 = 0 \rightarrow a = -1$</p>	<p>B1 (1)</p>
<p>2(c)</p>	<p>$z = \sqrt{5}$ or awrt 2.24 $\arctan, (-2) = 2.03$</p>	<p>B1 M1A1 (3)</p>
<p>2(d)</p>		<p>M1A1 B1ft (3)</p>
<p>2(e)</p>	<p>OP and QR are parallel, and QR is twice the length of OP Or Enlargement with Scale Factor 2 (centre O), followed by translation $\begin{pmatrix} -3 \\ -4 \end{pmatrix}$</p>	<p>B1B1 (2)</p>
		<p>(13 marks)</p>

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<p>3(a)</p>	<p>Correct quadrant with $(-24, -7)$ indicated.</p>	<p>B1</p> <p>(1)</p>
<p>3(b)</p>	$\arg z = -\pi + \tan^{-1}\left(\frac{7}{24}\right)$ $= -2.857798544\dots = -2.86 \text{ (2 dp)}$	$\tan^{-1}\left(\frac{7}{24}\right) \text{ or } \tan^{-1}\left(\frac{24}{7}\right)$ <p>awrt -2.86 or awrt 3.43</p> <p>M1</p> <p>A1</p> <p>(2)</p>
<p>3(c)</p>	$ w = 4, \arg w = \frac{5\pi}{6} \Rightarrow r = 4, \theta = \frac{5\pi}{6}$ $w = r \cos \theta + i r \sin \theta$ $w = 4 \cos\left(\frac{5\pi}{6}\right) + 4i \sin\left(\frac{5\pi}{6}\right)$ $= 4\left(\frac{-\sqrt{3}}{2}\right) + 4i\left(\frac{1}{2}\right)$ $= -2\sqrt{3} + 2i$	<p>Attempt to apply $r \cos \theta + i r \sin \theta$.</p> <p>Correct expression for w.</p> <p>either $-2\sqrt{3} + 2i$ or awrt $-3.5 + 2i$</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>(3)</p>
<p>3(d)</p>	$a = -2\sqrt{3}, b = 2$ $ z = \sqrt{(-24)^2 + (-7)^2} = \underline{25}$ $ zw = z \times w = (25)(4)$ $= \underline{100}$	$ z = 25 \text{ or}$ $zw = (48\sqrt{3} + 14) + (14\sqrt{3} - 48)i \text{ or}$ <p>awrt 97.1-23.8i</p> <p>Applies $z \times w$ or zw</p> <p>100</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>(3)</p>
		<p>(9 marks)</p>

Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

Question	Scheme	Marks	AOs
4(a)	$a = 1, d = 2$	B1	1.1b
	$b = 2$	B1	1.1b
	$c = -1$	B1	1.1b
		(3)	
(b)	$ z - i = z - 3i \Rightarrow y = 2$	B1	2.2a
	Area between the circles = $\pi \times 2^2 - \pi \times 1^2$	M1	1.1a
	 <p>Angle subtended at centre = $2 \times \cos^{-1}\left(\frac{1}{2}\right)$ Alternatively $(x+2)^2 + (y-1)^2 = 4, y = 2 \Rightarrow x = \dots$ Or $x = \sqrt{2^2 - 1^2}$ Leading to Angle subtended at centre = $2 \times \tan^{-1}\left(\frac{\sqrt{3}}{1}\right)$</p>	M1	3.1a
	Segment area = $\frac{1}{2} \times \frac{2\pi}{3} \times 2^2 - \frac{1}{2} \times 2^2 \times \sin\left(\frac{2\pi}{3}\right) \left\{ = \frac{4}{3}\pi - \sqrt{3} \right\}$	M1 A1	2.1 1.1b
	Area of Q: $\pi \times 2^2 - \pi \times 1^2 - \left(\frac{1}{2} \times \frac{2\pi}{3} \times 2^2 - \frac{1}{2} \times 2^2 \times \sin\left(\frac{2\pi}{3}\right) \right)$	M1	3.1a
	$= \frac{5\pi}{3} + \sqrt{3}$	A1	1.1b
		(7)	
(10 marks)			
Notes			
<p>(a) B1: Correct values for a and d B1: Correct value for b B1: Correct value for c</p> <p>(b) B1: Deduces that $z - i = z - 3i$ is a perpendicular bisector with equation $y = 2$, this may be drawn on a diagram. M1: Selects the correct procedure to find the area of the large circle – the area of the small circle. M1: Correct method to find the angle at the centre (or half this angle). Recognises that the hypotenuse is the radius of the larger circle and the adjacent is the radius of the smaller circle and using cosine Alternatively find where the perpendicular bisector intersects the larger circle so uses their $y = 2$</p>			

Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

and the equation of the larger circle in an attempt to establish the x values for the intersection points or uses geometry and Pythagoras to identify the required length and then uses tangent.

M1: Correct method for the area of the minor segment (allow equivalent work)

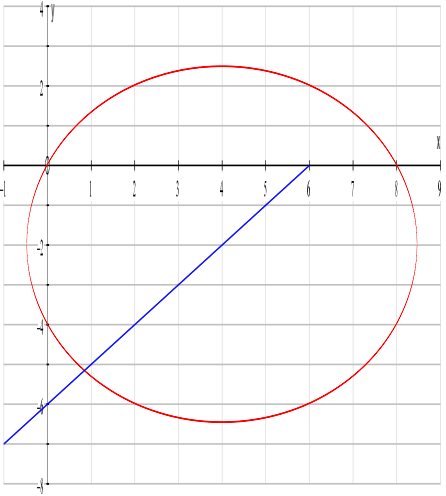
A1: Correct expression

M1: Fully correct strategy for the required area. Must be subtracting the area of the minor segment from the annulus area.

A1: Correct exact answer

Note: 6.968

Chapter 2 - Argand Diagrams – 56 Marks – 1 hour

<p>5(a)</p>	$ x + iy - 6i = 2 x + iy - 3 $ $x^2 + (y - 6)^2 = 4[(x - 3)^2 + y^2]$ $x^2 + y^2 - 12y + 36 = 4x^2 - 24x + 36 + 4y^2$ $3x^2 + 3y^2 - 24x + 12y = 0$ $(x - 4)^2 + (y + 2)^2 = 20$ <p>Centre $(4, -2)$, Radius $\sqrt{20} = 2\sqrt{5} = \text{awrt } 4.47$</p>	<p>M1 M1 A1 M1 A1 A1 (6)</p>
<p>5(b)</p>	 <p>Centre in correct quad for their circle</p> <p>Passes through O centre in 4th quad.</p> <p>Half line with positive gradient</p> <p>Correct position, clearly through (6, 0)</p>	<p>M1 A1cao B1 B1 (4)</p>
<p>5(c)</p>	<p>Equation of line $y = x - 6$</p> <p>Attempting simultaneous solution of $(x - 4)^2 + (y + 2)^2 = 20$ and $y = x - 6$</p> $x = 4 \pm \sqrt{10}$ $(4 - \sqrt{10}) + i(-2 - \sqrt{10})$	<p>B1 M1 A1 A1cao (4)</p>
		<p>(14 marks)</p>