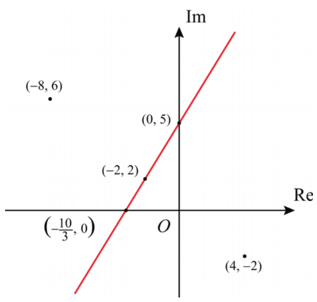
Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
1	States or implies that $w+z=\left(-2k+2\right)+\left(4+k\right)\mathrm{i}$	**M1**	1.1b	TBC
	Uses the definition of argument to write $\dfrac{4+k}{-2k+2}=\tan\left(\dfrac{3\pi}{4}\right)=-1$	**M1**	2.2a	
	Makes an attempt to solve for k, for example $4+k=2k-2$ is seen.	**M1**	1.1b	
	Finds $k=6$	**A1**	1.1b	
				(4 marks)

Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
2a	Finds $r = 12$, using $r^2 = (-6)^2 + (-6\sqrt{3})^2 \Rightarrow r^2 = 144 \Rightarrow r = 12$	**M1**	2.2a	TBC
	Finds $\arg z = -\frac{2\pi}{3}$. Likely states $\tan\theta = \frac{-6\sqrt{3}}{-6} \Rightarrow \theta = \frac{\pi}{3}$ and then deduces $\arg z = -\pi + \frac{\pi}{3} = -\frac{2\pi}{3}$	**M1**	2.2a	
	Writes $z = 12\left(\cos\left(-\frac{2\pi}{3}\right) + \mathrm{i}\sin\left(-\frac{2\pi}{3}\right)\right)$	**A1**	2.2a	
		(3)		
2b	States $\frac{z}{w} = \frac{12}{4}\left(\cos\left(-\frac{2\pi}{3} + \frac{\pi}{2}\right) + \mathrm{i}\sin\left(-\frac{2\pi}{3} + \frac{\pi}{2}\right)\right)$. Award one method mark for $\frac{12}{4}$ seen and one method mark for $-\frac{2\pi}{3} - \left(-\frac{\pi}{2}\right)$ or $-\frac{2\pi}{3} + \frac{\pi}{2}$ seen.	**M2**	2.2a	TBC
	States a fully correct answer: $\frac{z}{w} = 3\left(\cos\left(-\frac{\pi}{6}\right) + \mathrm{i}\sin\left(-\frac{\pi}{6}\right)\right)$	**A1**	1.1b	
		(3)		
				(6 marks)

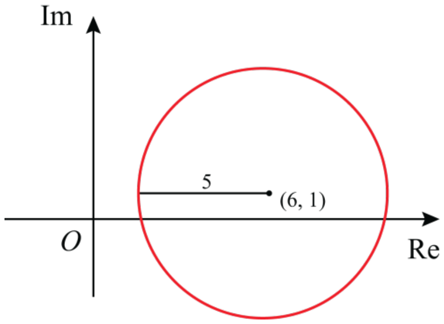
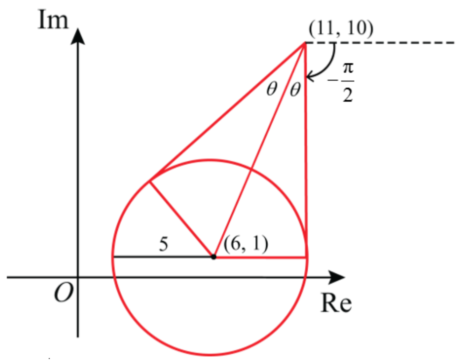
Notes

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	Deduces that the midpoint of (−8, 6) and (4, −2) is (−2, 2)	**M1**	2.2a	TBC
	Calculates that the slope of the line joining (−8, 6) and (4, −2) is $-\frac{2}{3}$	**M1**	1.1b	
	Deduces that the slope of the perpendicular bisector is $\frac{3}{2}$	**M1**	2.2a	
	Finds the correct equation of the locus (perpendicular bisector): $y = \frac{3}{2}x + 5$	**A1**	1.1b	
		(4)		
3b	**Figure 2**  Draws a straight line with a positive slope.	**M1**	1.1b	TBC
	Fully correct answer with (0, 5) and $\left(-\frac{10}{3}, 0\right)$ labelled.	**A1**	1.1b	
		(2)		
3c	Demonstrates an understanding of the need to find the point of intersection of $y = -\frac{2}{3}x$ and $y = \frac{3}{2}x + 5$	**M1**	2.2a	TBC
	Solves to find $x = -\frac{30}{13}$ and $y = \frac{20}{13}$	**M1**	1.1b	
	Finds the distance: $d_{\min} = \sqrt{\left(-\frac{30}{13}\right)^2 + \left(\frac{20}{13}\right)^2} \Rightarrow d_{\min} = \frac{10}{13}\sqrt{13}$	**A1**	2.1	
		(3)		
				(9 marks)

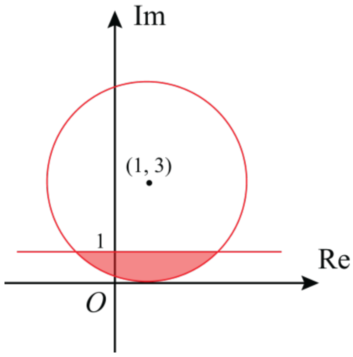
Notes

3a

An alternative algebraic approach is acceptable.

Q	Scheme		Marks	AOs	Pearson Progression Step and Progress descriptor
4a	**Figure 3** 	Circle drawn with centre (6, 1).	**M1**	1.1b	TBC
		Circle should clearly cross the real axis and not touch the imaginary axis.	**A1**	2.2a	
			(2)		
4b	Draws a line from the point (11, 10) that is tangential to the circle with centre (6, 1) and radius 5.		**M1**	2.2a	TBC
	States or implies that length of the opposite side is 5 (the radius of the circle).		**M1**	1.1b	
	Calculates the length of the hypotenuse of this triangle is $\sqrt{106}$.		**M1**	1.1b	
	Deduces that $\theta = \arcsin\left(\frac{5}{\sqrt{106}}\right)$		**M1**	1.1b	
	Figure 4 	Clearly explains that the minimum angle is $-\frac{\pi}{2} - 2\arcsin\left(\frac{5}{\sqrt{106}}\right)$ with explanation referring to a diagram or providing a clear explanation. For example, as shown in the diagram opposite.	**A1**	2.1	
			(5)		
					(7 marks)

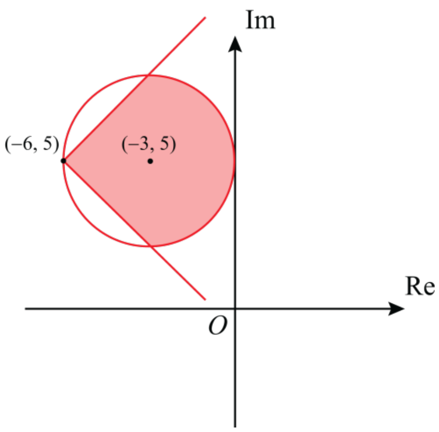
Notes

Q	Scheme		Marks	AOs	Pearson Progression Step and Progress descriptor
5	**Figure 5** 	Circle drawn with centre (1, 3).	**M1**	1.1b	TBC
		Circle should just touch the real axis and clearly cross the imaginary axis.	**A1**	1.1b	
		Points (−2, −2) and (−2, 4) indicated on the diagram.	**M1***	1.1b	
		Line drawn at $y = 1$.	**A1**	2.2a	
		Shades correct region.	**M1**	3.1a	
		Fully correct solution.	**A1**	1.1b	
					(6 marks)

Notes

5

Award the method mark providing the line $y = 1$ is drawn correctly, even if the points (−2, −2) and (−2, 4) are not indicated.

Q	Scheme		Marks	AOs	Pearson Progression Step and Progress descriptor
6	**Figure 6** 	Circle drawn with centre (−3, 5).	**M1**	1.1b	TBC
		Circle should just touch the imaginary axis and clearly not touch the real axis.	**A1**	1.1b	
		Two half lines drawn on the diagram.	**M1**	1.1b	
		Half lines start at (−6, 5) and intersect the circle at the top and the bottom.	**A1**	2.2a	
		Shades correct region.	**M1**	3.1a	
		Fully correct solution.	**A1**	1.1b	
					(6 marks)

Notes