

<b>1</b>		B1	Establish result true for $n = 1$ or $n = 2$
		M1	Add next term to given sum formula
		M1	Attempt to factorise or expand and simplify to correct expression
		A1	Correct expression obtained
		A1	<b>5</b> Specific statement of induction conclusion

**5**

<b>2</b>	<b>(i)</b> (-7)	M1	Obtain a single value
		A1	<b>2</b> Obtain correct answer as a matrix

<b>(ii)</b>	$BA = \begin{pmatrix} 5 & -20 \\ 3 & -12 \end{pmatrix}$	M1	Obtain a $2 \times 2$ matrix
	$\begin{pmatrix} -7 & -20 \\ 11 & -20 \end{pmatrix}$	A1	All elements correct
		B1	<b>4C</b> seen or implied by correct answer
		B1ft	<b>4</b> Obtain correct answer, ft for a slip in <b>BA</b>

**6**

<b>3</b>	Either	M1	Express as a sum of 3 terms
		M1	Use standard sum results
	$\frac{2}{3}n(n+1)(2n+1) - 2n(n+1) + n$	A1	Correct unsimplified answer
		M1	Attempt to factorise
		A1	Obtain at least factor of $n$ and a quadratic
		A1	<b>6</b> Obtain correct answer a.e.f.
	<b>Or</b>		
	$\sum_{r=1}^{2n} r^2 - 4 \sum_{r=1}^n r^2$	M1	Express as difference of 2 $\sum r^2$ series
		M1	Use standard result
	$\frac{1}{6} \times 2n(2n+1)(4n+1) - 4 \times \frac{1}{6}n(n+1)(2n+1)$	A1	Correct unsimplified answer
		M1	Attempt to factorise
		A1	Obtain at least factor of $n$
	$\frac{1}{3}n(2n-1)(2n+1)$	A1	Obtain correct answer

**6**

4 (i)  $5 + 12i$  B1B1 Correct real and imaginary parts  
 13 B1ft Correct modulus  
 $67.4^\circ$  or 1.18 B1ft 4 Correct argument

(ii) M1 Multiply by conjugate  
 A1 Obtain correct numerator  

$$-\frac{11}{85} - \frac{27}{85}i$$
 A1 3 Obtain correct denominator  
 7

5 (a)  $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$  B1B12 Each column correct  
**SC B2 use correct matrix from MF1**  
**Can be trig form**

(b) (i) B1B12 Stretch, in  $x$ -direction sf 5  
 (ii) B1B12 Rotation,  $60^\circ$  clockwise  
 6

6 (i) (a) B1B12 Circle centre  $(3, -4)$ , through origin  
 (b) B1B12 Vertical line, clearly  $x = 3$

(ii) B1ft Inside their circle  
 B1ft 2 And to right of their line, if vertical  
 6

7

*Either*

$$\alpha + \beta = -2k \quad \alpha\beta = k$$

$$y^2 - 4ky + 4k = 0$$

*Or*

$$\alpha + \beta = -2k$$

$$\frac{-2k}{\alpha}$$

$$y = \frac{-2k}{x}$$

$$y^2 - 4ky + 4k = 0$$

*Or*

$$-k \pm \sqrt{k^2 - k}$$

$$\frac{\alpha + \beta}{\alpha} = \frac{2k}{k + \sqrt{k^2 - k}}, \quad \frac{\alpha + \beta}{\beta} = \frac{2k}{k - \sqrt{k^2 - k}}$$

$$y^2 - 4ky + 4k = 0$$

- B1B1 State or use correct results
- M1 Attempt to find sum of new roots
- A1 Obtain  $4k$
- M1 Attempt to find product of new roots
- A1 Obtain  $4k$
- B1ft 7 Correct quadratic equation a.e.f.

- B1 State or use correct result
- B1 State or imply form of new roots
- B1 State correct substitution
- M1 Rearrange and substitute for  $x$
- A1 Correct unsimplified equation
- M1 Attempt to clear fractions
- A1 Correct quadratic equation a.e.f.

- B1 Find roots of original equation
- B1 Express both new roots in terms of  $k$
- M1 Attempt to find sum of new roots
- A1 Obtain  $4k$
- M1 Attempt to find product of new roots
- A1 Obtain  $4k$
- B1ft Correct quadratic equation a.e.f.

8	(i)	M1 A1	Attempt to rationalise denominator or cross multiply 2 Obtain <b>given</b> answer correctly
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	(ii)	M1 M1 A1 A1 M1 A1	Express terms as differences using (i) Attempt this for at least 1 <sup>st</sup> three terms 1 <sup>st</sup> three terms all correct Last two terms all correct Show pairs cancelling 6 Obtain correct answer, in terms of $n$
			$\frac{1}{2}(\sqrt{n+2} + \sqrt{n+1} - \sqrt{2} - 1)$
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	(iii)	B1	1 <b>9</b> Sensible statement for divergence
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9	(i)	M1 M1 A1	Show correct expansion process for 3 x 3 Correct evaluation of any 2 x 2 3 Obtain correct answer
			$\det \mathbf{A} = a^2 - a$
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	(ii)	M1 A1 M1 A1 B1 B1	Find a pair of inconsistent equations State inconsistent or no solutions Find a repeated equation State non unique solutions State that $\det \mathbf{A}$ is non-zero or find correct solution 6 State unique solution <b>SC if <math>\det \mathbf{A}</math> incorrect, can score 2 marks for correct deduction of a unique solution, but only once</b>
	(a)		
	(b)		
	(c)		
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10	(i)	M1 A1 M1 M1 A1	Attempt to equate real and imaginary parts Obtain both results Eliminate to obtain quadratic in $x^2$ or $y^2$ Solve to obtain $x$ or $y$ value 5 Obtain correct answer as a complex no.
			$x^2 - y^2 = 3 \quad xy = 2$ $z = 2 + i$
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	(ii)	B1	1 Obtain <b>given</b> answer correctly
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	(iii)	M1 A1 M1 M1 A1	Attempt to solve quadratic equation Obtain correct answers Choose negative sign Relate required value to conjugate of (i) 5 Obtain correct answer
			$w^3 = 2 \pm 11i$ $w = 2 - i$
			<b>11</b>