# 1.12 Complex numbers introduction\_P\_1

**1a.** *[2 marks]*

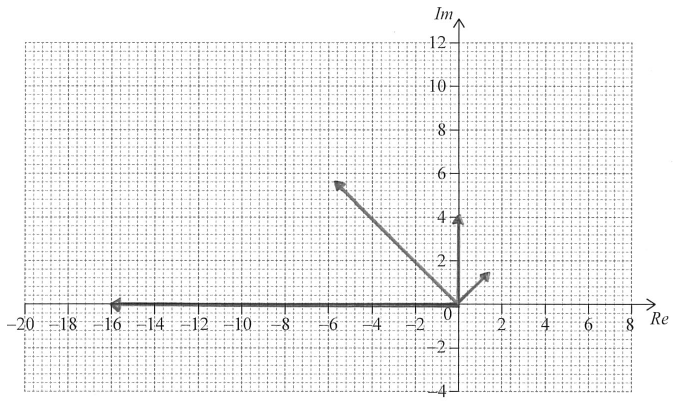
## Markscheme

, ,   (,  ,  ) ***(M1)A1***

***[2 marks]***

**1b.** *[3 marks]*

## Markscheme

 ***A3***

**Note:** Award ***A1*** for correct arguments, award ***A1*** for  and −16 clearly indicated, award ***A1*** for |  | < 4 and 4 < |  | < 16.

***[3 marks]***

**1c.** *[2 marks]*

## Markscheme

       ***M1***

       ***A1***

***[2 marks]***

**2a.** *[5 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



use of De Moivre’s theorem      ***(M1)***

      ***(A1)***

,       ***(A1)***

 1, 2, 3, 4, 5

 or  or  or  or       ***A2***

**Note:** Award ***A1*** if additional roots are given or if three correct roots are given with no incorrect (or additional) roots.

***[5 marks]***

**2b.** *[4 marks]*

## Markscheme

Re *S* = 

Im *S* =       ***A1***

**Note:** Award ***A1*** for both parts correct.

but ,  ,  ,   and       ***M1A1***

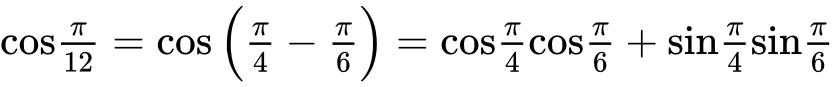
⇒ Re *S* = Im *S****AG***

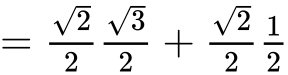
**Note:** Accept a geometrical method.

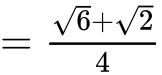
***[4 marks]***

**2c.** *[3 marks]*

## Markscheme

      ***M1A1***

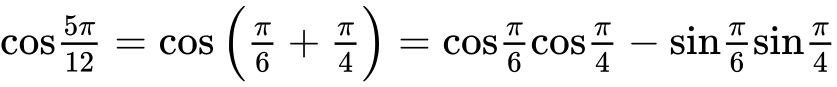


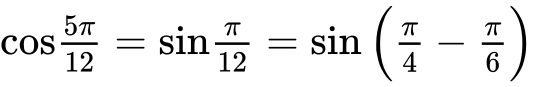
***A1***

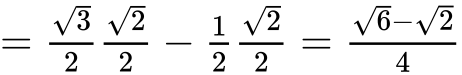
***[3 marks]***

**2d.** *[4 marks]*

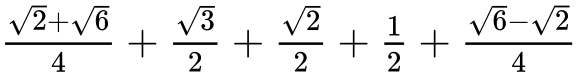
## Markscheme

      ***(M1)***

**Note:** Allow alternative methods *eg* .

      ***(A1)***

Re *S* = 

Re *S* =       ***A1***

      ***A1***



*S* = Re(*S*)(1 + i) since Re *S* = Im *S*,      ***R1***

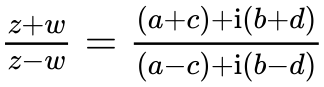
*S* =       ***AG***

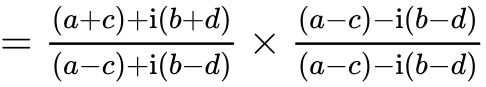
***[4 marks]***

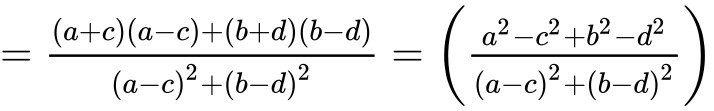
**3a.** *[4 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



     ***M1A1***

real part      ***A1A1***

**Note**: Award ***A1***for numerator, ***A1***for denominator.

***[4 marks]***

**3b.** *[2 marks]*

## Markscheme

     ***R1***

hence real part = 0      ***A1***

**Note:** Do not award ***R0A1***.

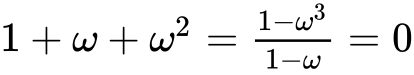
***[2 marks]***

**4a.** *[4 marks]*

## Markscheme

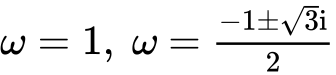
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

(i)     **METHOD 1**

    ***A1***

as      ***R1***

**METHOD 2**

solutions of  are      ***A1***

verification that the sum of these roots is 0     ***R1***

(ii)          ***A2***

***[4 marks]***

**4b.** *[4 marks]*

## Markscheme

    ***M1A1***

**EITHER**

    ***M1***

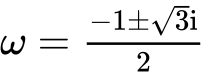
    ***A1***

**OR**

    ***M1***

    ***A1***

**OR**

substitution by  in any form     ***M1***

numerical values of each term seen     ***A1***

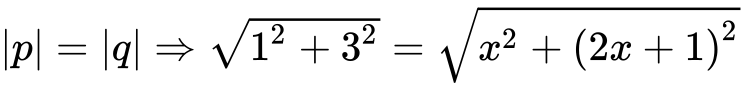
**THEN**

    ***AG***

***[4 marks]***

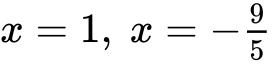
**4c.** *[5 marks]*

## Markscheme

    ***(M1)(A1)***

    ***A1***

    ***(M1)***

    ***A1***

***[5 marks]***

**4d.** *[6 marks]*

## Markscheme

    ***M1A1***

    ***M1***

    ***A1***

    ***M1***

    ***A1***

***[6 marks]***

**5a.** *[6 marks]*

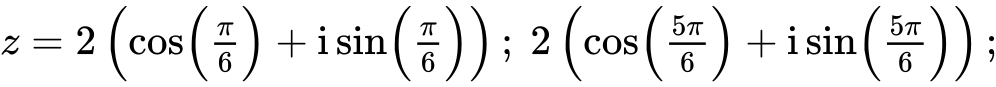
## Markscheme

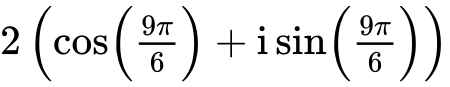
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**Note:** Accept answers and working in degrees, throughout.

     ***(A1)***

attempt the use of De Moivre’s Theorem in reverse     ***M1***



     ***A2***

**Note:** Accept cis form.

     ***A2***

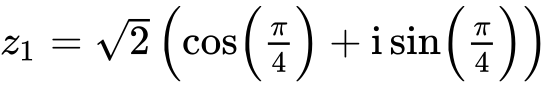
**Note:** Award ***A1*** for two correct solutions in each of the two lines above.

***[6 marks]***

**5b.** *[11 marks]*

## Markscheme

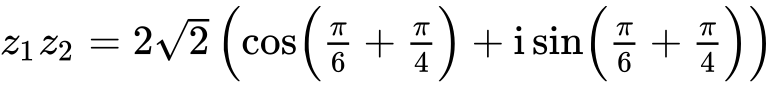
**Note:** Accept answers and working in degrees, throughout.

(i)          ***A1A1***

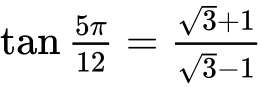
(ii)     

     ***M1***

     ***A1***

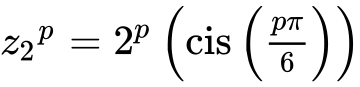
(iii)          ***M1A1***

**Note:** Interpret “hence” as “hence or otherwise”.

     ***A1***

     ***M1A1***

**Note:** Award final ***M1*** for an attempt to rationalise the fraction.

(iv)          ***(M1)***

 is a positive real number when      ***A1***

**Note:** Accept a solution based on part (a).

***[11 marks]***

***Total [17 marks]***

**6.** *[17 marks]*

## Markscheme

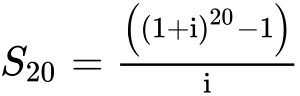
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

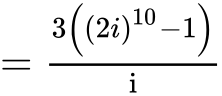
(a)          ***(A1)***

     ***M1***

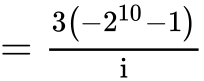
     ***A1***

***[3 marks]***

(b)          ***(M1)***

     ***(M1)***

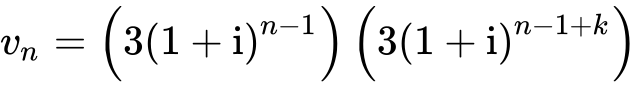
**Note:**     Only one of the two ***M1***s can be implied. Other algebraic methods may be seen.

     ***(A1)***

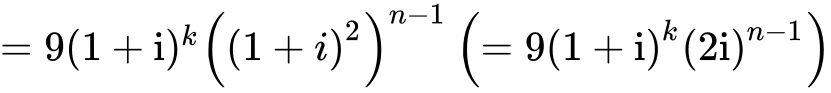
     ***A1***

***[4 marks]***

(c)     (i)     **METHOD 1**

     ***M1***

     ***A1***

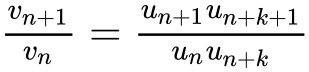


this is the general term of a geometrical sequence     ***R1AG***

**Notes:**     Do not accept the statement that the product of terms in a geometric sequence is also geometric unless justified further.

     If the final expression for  is  award ***M1A1R0***.

**METHOD 2**

     ***M1***

     ***A1***

this is a constant, hence sequence is geometric     ***R1AG***

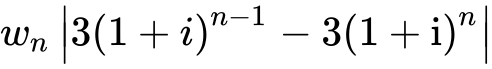
**Note:**     Do not allow methods that do not consider the general term.

(ii)          ***A1***

(iii)     common ratio is  (which is independent of *k*)     ***A1***

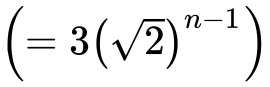
***[5 marks]***

(d)     (i)     **METHOD 1**

     ***M1***

     ***M1***

     ***A1***



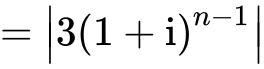
this is the general term for a geometric sequence   ***R1AG***

**METHOD 2**

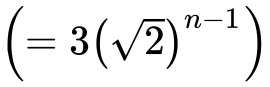
     ***M1***



     ***A1***



     ***A1***



this is the general term for a geometric sequence     ***R1AG***

**Note:**     Do not allow methods that do not consider the general term.

(ii)     distance between successive points representing  in the complex plane forms a geometric sequence     ***R1***

**Note:**     Various possibilities but must mention distance between successive points.

***[5 marks]***

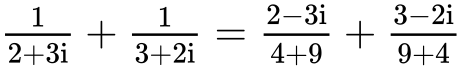
***Total [17 marks]***

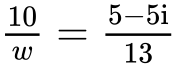
**7.** *[7 marks]*

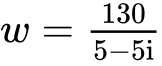
## Markscheme

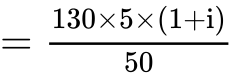
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

(a)     **METHOD 1**

     ***M1A1***

     ***A1***

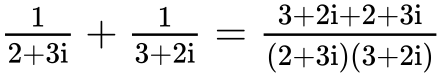


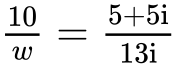


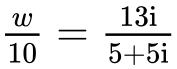
     ***A1***

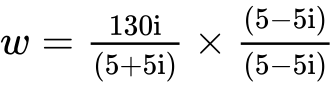
***[4 marks]***

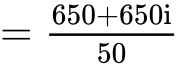
**METHOD 2**

     ***M1A1***

     ***A1***



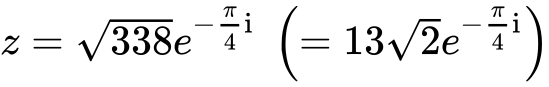


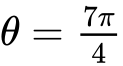


     ***A1***

***[4 marks]***

(b)     *w*\*      ***A1***

     ***A1A1***

**Note:**     Accept .

     Do not accept answers for  given in degrees.

***[3 marks]***

***Total [7 marks]***

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