Complex Numbers and Quadratic Equations

Standard difficulty · 20 questions · 40 marks · Time: 36 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer 8 × 1 = 8 marks

1. i^{-33} equals:

(a) i **(b)** 1 **(c)** −1 **(d)** −i

2. (6 + 5i)(5 + 4i) equals:

(a) 50 + 49i **(b)** 30 + 20i **(c)** 10 + 49i **(d)** 10 − 49i

3. The modulus of −12 − 5i is:

(a) 7 **(b)** 17 **(c)** 169 **(d)** 13

4. (1 − 3i) + (3 − i) equals:

(a) −2 − 4i **(b)** 4 − 4i **(c)** −2 − 2i **(d)** 4 − 2i

5. i^2 equals:

(a) 0 **(b)** 1 **(c)** −1 **(d)** i

6. The roots of $x^2 + 2x + 17 = 0$ are:

(a) −1 + 4i and −1 − 4i **(b)** 3 and −5

(c) −1 + 8i and −1 − 8i **(d)** 1 + 4i and 1 − 4i

7. The multiplicative inverse of 1 − 3i is:

(a) 1/10 − (3/10)i **(b)** 1 + 3i

(c) 1/10 + (3/10)i **(d)** −1/10 − (3/10)i

8. Assertion (A): The modulus of 12 + 5i is 17.
Reason (R): $|a + ib| = \sqrt{(a^2 + b^2)}$.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer 8 × 2 = 16 marks

9. Express (1 + 7i)(2 − 4i) in the form a + ib.

10. Express (2 + 3i) ÷ (5 + 4i) in the form a + ib.

11. Solve $x^2 + 3x + 4 = 0$.

12. If $z = -2 + i$, find z^2 and z^3.

13. Simplify $i^{38} + i^{47} + i^{11}$.

14. Find real numbers x and y if $(x + 6) + (y - 3)i = 4 + 6i$.

15. For $z = 8 + 2i$, find its conjugate, its modulus and its multiplicative inverse.

16. For $z_1 = -20 + 21i$ and $z_2 = 4 + 3i$, find $|z_1|$, $|z_2|$ and $|z_1z_2|$. Check that $|z_1z_2| = |z_1|\,|z_2|$.

Section C — Word problems — 4 × 4 = 16 marks

17. If $z_1 = 3 + 4i$ and $z_2 = 3 + 4i$, find (a) $z_1 + z_2$, (b) $z_1 - z_2$, (c) z_1z_2, (d) $z_1 \div z_2$.

18. Solve $2x^2 - 4x + 10 = 0$. Check that the sum of the roots is $-b/a$ and their product is c/a.

19. Show that $(1 - i)^2 = -2i$, and hence find $(1 - i)^8$.

20. Find real numbers x and y such that $(x + iy)^2 = -2i$, and so find the square roots of $-2i$.

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Answer key

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Q	Answer	Working
1	**(d) −i**	$-33 = 4 \times -9 + 3$
2	**(c) 10 + 49i**	$30 + 49i + 20i^2$, and $i^2 = -1$
3	**(d) 13**	$\sqrt{(12^2 + 5^2)} = \sqrt{169}$
4	**(b) 4 − 4i**	combine the real parts and the imaginary parts
5	**(c) −1**	—
6	**(a) −1 + 4i and −1 − 4i**	$D = 4 - 68 = -64$
7	**(c) 1/10 + (3/10)i**	$\bar{z} \div \lvert z\rvert^2 = (1 + 3i) \div 10$
8	**(d) A is false, but R is true.**	A is false: $\sqrt{(12^2 + 5^2)} = 13$. R is true.
9	**30 + 10i**	$2 - 4i + 14i - 28i^2$
10	**22/41 + (7/41)i**	multiply top and bottom by 5 − 4i; the denominator becomes 41
11	**x = −3/2 ± (√7/2)i**	$D = 9 - 16 = -7$; $x = (-3 \pm \sqrt{(-7)}) \div 2$
12	**$z^2 = 3 - 4i$; $z^3 = -2 + 11i$**	$z^3 = z^2 \times z$
13	**−1 − 2i**	$i^{38} = -1$, $i^{47} = -i$, $i^{11} = -i$
14	**x = −2, y = 9**	equate the real parts and the imaginary parts
15	**$\bar{z} = 8 - 2i$; $\lvert z\rvert = 2\sqrt{17}$; $z^{-1} = 2/17 - (1/34)i$**	$\lvert z\rvert^2 = 68$
16	**$\lvert z_1\rvert = 29$, $\lvert z_2\rvert = 5$, $z_1z_2 = -143 + 24i$, $\lvert z_1z_2\rvert = 145 = 29 \times 5$**	—
17	**(a) 6 + 8i; (b) 0; (c) −7 + 24i; (d) 1**	for (d), multiply top and bottom by 3 − 4i
18	**x = 1 ± 2i, i.e. 1 + 2i and 1 − 2i. Sum = 2, and −b/a = 4/2 = 2; product = 5, and c/a = 10/2 = 5.**	$D = -64$
19	**$(1 - i)^2 = 1 - 2i + i^2 = -2i$; $(1 - i)^8 = (-2i)^4 = 16$**	$(-1)^4 \times 2^4 \times i^4$
20	**$x^2 - y^2 = 0$ and $2xy = -2$, giving x = 1, y = −1 or x = −1, y = 1. Square roots: ±(1 − i)**	try $x^2 + y^2 = \lvert -2i\rvert = 2$

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