FREE SAMPLE: THE FIRST QUESTION

Question One (9 marks)

(a) Write $(-2 + 2i)(4 + 6i) \div (5 - 2i)$ in the form $a + bi$, where a and b are real numbers (exact fractions if needed).

[3 marks]

(b) Write $z = 3 - 6i$ in polar form $r \operatorname{cis} \theta$, where $r > 0$ and $-\pi < \theta \leq \pi$. Give r exactly and θ in radians to 3 significant figures.

[3 marks]

(c) Solve $2z^2 + 50 = 0$ for z, giving the solutions in the form $a + bi$.

[3 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (9 marks) [Arithmetic, polar form and quadratics]

(a) Write $(-2 + 2i)(4 + 6i) \div (5 - 2i)$ in the form a + bi, where a and b are real numbers (exact fractions if needed).

(a) Answer: $\frac{-92}{29} - \frac{60i}{29}$

- Evidence level: Achieved (multiply complex numbers, then divide using the conjugate).
- Numerator: $(-2 + 2i)(4 + 6i) = -20 - 4i$.
- Multiply top and bottom by the conjugate of the denominator, 5 + 2i: denominator $= 5^2 + 2^2 = 29$.
- Numerator × conjugate $= (-20 - 4i)(5 + 2i) = -92 - 60i$.
- Divide both parts by 29: $\frac{-92}{29} - \frac{60i}{29}$.

> **KEY TAKEAWAY**
> Dividing complex numbers: multiply numerator and denominator by the conjugate of the denominator so the denominator becomes the real number $a^2 + b^2$.

(b) Write $z = 3 - 6i$ in polar form r cis θ, where $r > 0$ and $-\pi < \theta \leq \pi$. Give r exactly and θ in radians to 3 significant figures.

(b) Answer: $z = \sqrt{45}\ \text{cis}(-1.11)$

- Evidence level: Achieved (find the modulus and the argument, taking care over the quadrant).
- Modulus $r = \sqrt{(3)^2 + (-6)^2} = \sqrt{45} = 6.708$.
- The point (3, −6) is in the fourth quadrant, so use $\theta = \arctan(|b/a|)$ and adjust: $\theta = -1.11$ radians.
- $z = \sqrt{45}\ \text{cis}(-1.11)$.

> **KEY TAKEAWAY**
> Polar form: $r = \sqrt{(a^2 + b^2)}$; sketch the point to choose the correct quadrant for θ (your calculator's arctan only gives the first or fourth quadrant).

(c) Solve $2z^2 + 50 = 0$ for z, giving the solutions in the form a + bi.

(c) Answer: z = 5i or z = −5i

- Evidence level: Achieved (use the quadratic formula when the discriminant is negative).
- $\Delta = b^2 - 4ac = 0 - 400 = -400$.
- $\sqrt{\Delta} = \sqrt{(-400)} = 20i$, because $\sqrt{(-n)} = i\sqrt{n}$.
- $z = (0 \pm 20i) \div 4$.
- $z = 5i$ or $z = -5i$.

> **KEY TAKEAWAY**
> A negative discriminant gives a conjugate pair: $\sqrt{(-n)} = i\sqrt{n}$, so the roots are $(-b \pm i\sqrt{|\Delta|}) \div 2a$.

LOS: Arithmetic, polar form and quadratics (91577)

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