3. **In this question you must show all stages of your working.**

Solutions relying entirely on calculator technology are not acceptable.

$$f(z) = 4z^3 + pz^2 - 24z + 108$$

where p is a constant.

Given that -3 is a root of the equation $f(z) = 0$

(a) determine the value of p

(2)

(b) using algebra, solve $f(z) = 0$ completely, giving the roots in simplest form,

(4)

(c) determine the modulus of the complex roots of $f(z) = 0$

(2)

(d) show the roots of $f(z) = 0$ on a single Argand diagram.

(2)

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Question 3 continued

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Question 3 continued

(Total for Question 3 is 10 marks)