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

Solutions relying entirely on calculator technology are not acceptable.

$$f(z) = z^3 - 13z^2 + 59z + p \qquad p \in \mathbb{Z}$$

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

(a) show that $p = -87$

(2)

(b) Use algebra to determine the other roots of $f(z) = 0$, giving your answers in simplest form.

(4)

On an Argand diagram

- the root $z = 3$ is represented by the point P
- the other roots of $f(z) = 0$ are represented by the points Q and R
- the number $z = -9$ is represented by the point S

(c) Show on a single Argand diagram the positions of P, Q, R and S

(1)

(d) Determine the perimeter of the quadrilateral $PQSR$, giving your answer as a simplified surd.

(2)

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Question 2 continued

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Question 2 continued

(Total for Question 2 is 9 marks)