Question 4 (7 marks)
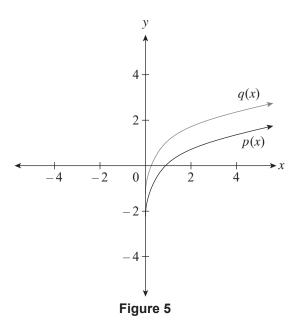
Consider the functions $p(x) = \ln x$ and $q(x) = \ln 3x$.

Figure 5 shows the graphs of $y = p(x)$ and $y = q(x)$.
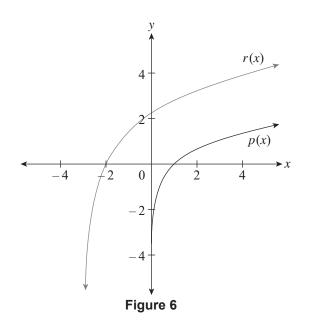

Figure 5

(a) Show that $p'(x) = q'(x)$.

(2 marks)

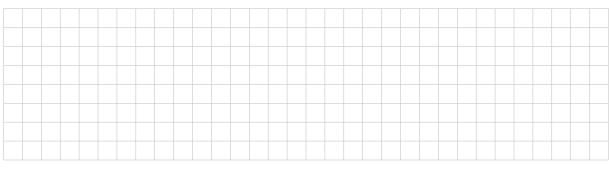(b) Describe the relationship between the graphs of $y = p(x)$ and $y = q(x)$.

(1 mark)

Consider the function $r(x) = \ln\left(x^2 + 6x + 9\right)$ with domain $x > -3$.

Figure 6 shows the graphs of $y = p(x)$ and $y = r(x)$.

Figure 6
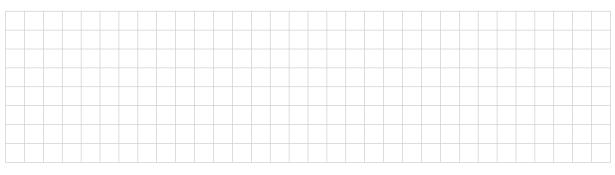
(c) The function $r(x)$ can be written in the form $a\ln(x + b)$, where a and b are positive integers.

(i) Determine the values of a and b.

(2 marks)

(ii) Hence, describe the relationship between the graphs of $y = p(x)$ and $y = r(x)$.

(2 marks)

PLEASE TURN OVER