4 **(a)** **(i)** Given that $y = 3\sin^2 x + \cos x$, show that $y + \cot x \frac{\mathrm{d}y}{\mathrm{d}x} = k(1 + \cos^2 x)$, where k is an integer. [4]

(ii) Using your value of k, solve the equation $k(1 + \cos^2 x) = 4$ for $-\pi \leqslant x \leqslant \pi$. [4]

(b) (i) Differentiate $y = \tan\left(x - \sqrt{x}\right)$ with respect to x. [2]

(ii) Hence find $\int \frac{2\sqrt{x} - 1}{\sqrt{x}\cos^2\left(x - \sqrt{x}\right)} \mathrm{d}x$. [2]

5 Variables x and y are related by the equation $y = \frac{x}{\ln 3x}$. Use differentiation to find the approximate change in y when x increases from 1 to $1 + h$, where h is small. [4]