Question 14 **(13 marks)**

The intensity of light travelling through a medium decreases due to scattering and absorption. The intensity of light, I, after travelling a distance of x centimetres through a soft tissue sample is given by

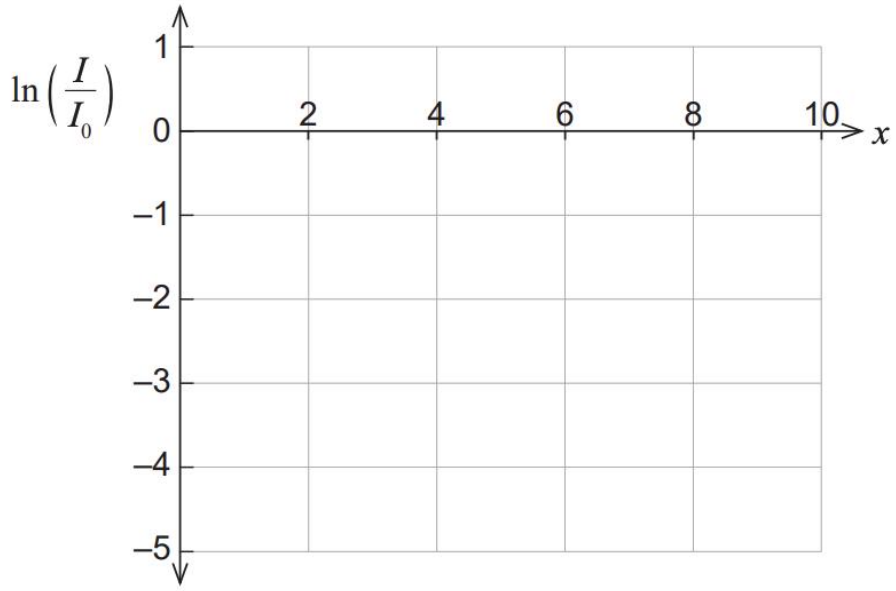
$$I = I_0 e^{-0.75x}$$

where I_0 is the initial light intensity.

(a) What percentage of the initial light intensity remains after the light has travelled 1 cm through the soft tissue? (2 marks)

(b) After how many centimetres will the light intensity have reached one quarter of its initial value? (2 marks)

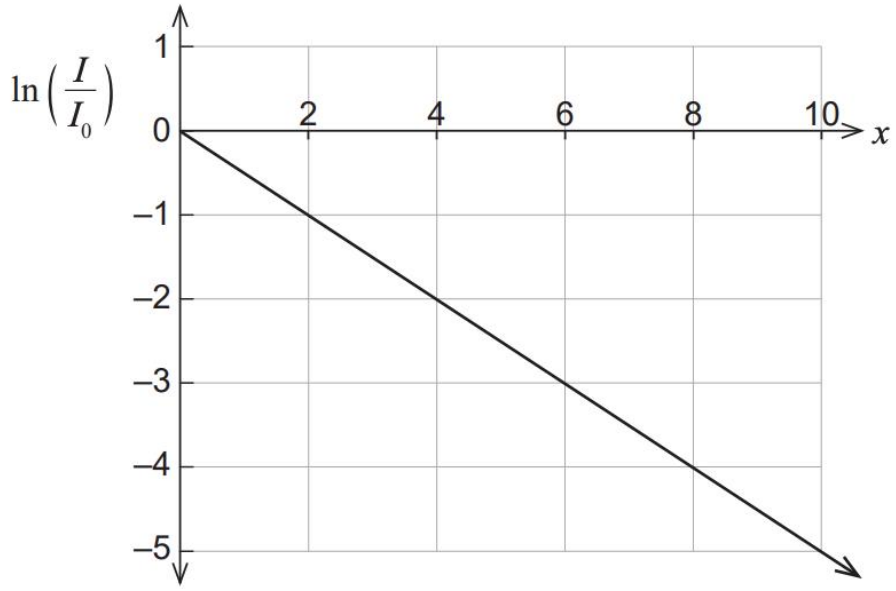
(c) Determine an expression for $\ln\left(\frac{I}{I_0}\right)$, and hence plot $\ln\left(\frac{I}{I_0}\right)$ versus x on the axes below. (3 marks)



The intensity of light passing through a different type of soft tissue satisfies the equation

$$I = I_0 e^{-\mu x}$$

where μ is the attenuation constant. Light intensity measurements were made on a sample of soft tissue, and the results plotted in the graph below.



(d) Use the graph to determine the value of the attenuation constant, μ. (1 mark)

(e) (i) Express the equation $I = I_0 e^{-0.75x}$ using base 10 (in the form $I = I_0 10^{-bx}$). State the value of b to three decimal places. (3 marks)

(ii) Describe the change in intensity over a distance of $\frac{1}{b}$ cm. (2 marks)