Question 18 **(7 marks)**

The ear has the remarkable ability to handle an enormous range of sound levels. In order to express levels of sound meaningfully in numbers that are more manageable, a logarithmic scale is used, rather than a linear scale. This scale is the decibel (dB) scale.

The sound intensity level, L, is given by the formula below:

$L = 10\log\left(\frac{I}{I_0}\right)$ dB where I is the sound intensity and I_0 is the reference sound intensity.

I and I_0 are measured in watt/m^2.

(a) Listening to a sound intensity of 5 billion times that of the reference intensity $\left(I = 5 \times 10^9 I_0\right)$ for more than 30 minutes is considered unsafe. To what sound intensity level does this correspond? (2 marks)

(b) The reference sound intensity, I_0, has a sound intensity level of 0 dB. If a household vacuum cleaner has a sound intensity $I = 1 \times 10^{-5}$ watt/m^2 and this corresponds to a sound intensity level $L = 70$ dB, determine I_0. (2 marks)

The average sound intensity level for rainfall is 50 dB and for heavy traffic 85 dB.

(c) How many times more intense is the sound of traffic than that of rainfall? (3 marks)