**Answer 3. (a)**

Now according to the Heaps' Law:

$$v = k.n^{\beta} \text{----------(1)}$$

Where $\beta = 0.5$, v is vocabulary size (number of unique words), n is the number of words in corpus,
k, $\beta$ are parameters that vary for each corpus (typical values given are $10 \leq k \leq 100$ and $\beta = 0.5$

For full 100% of the vocabulary

So we get the equation as below for 100% vocabulary, $\beta = 0.5$, n1 is the number of words in corpus

$$100v = k.(n1)^{0.5} \text{ ----------(2)}$$

Now the equation for the 90% of vocabulary, $\beta = 0.5$, n2 is the number of words in corpus

$$90v = k.(n2)^{0.5} \text{----------(3)}$$

To find the proportion of a collection of text before 90% of its vocabulary has been encountered we have to divide equation (3) by equation (2) and calculate the n2/n1

After dividing equation-by-equation (2) we get the following

$$\frac{9}{10} = \left(\frac{n2}{n1}\right)^{0.5}$$

$$(0.9)^2 = (\frac{n2}{n1})$$

**Proportion of a collection of text must be read before 90% of the vocabulary has been encountered= 0.81**