

# How Many Bibles Can Fit on the Head of a Pin

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On December 29, 1959 Richard Feynman gave an address (There's Plenty of Room at the Bottom) in which he calculated how many Encyclopaedia Britannicas could fit on the head of a pin. Legend identifies this event as the beginning of the field of theoretical nanotechnology.

To illustrate to general chemistry students how small nanoscopic entities, such as atoms, are I calculate with the following simple model how many bibles can fit on the head of a pin.

The model assumes that the pinhead surface is made up of Fe atoms packed in a simple squaric array. It further assumes that letters would be made by placing adatoms in the pockets created by the surface Fe atoms using a scanning tunneling microscope, and that 100 pinhead surface Fe atoms would be required to form a letter.

The first step is to calculate the number of Fe atoms on the pinhead.

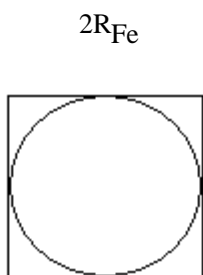
Radius of pinhead:  $R_{\text{PH}} := \frac{1}{32} \cdot \text{in}$   $R_{\text{PH}} = 7.94 \times 10^8 \text{ pm}$

Area of pinhead:  $\text{Area}_{\text{PH}} := \pi \cdot R_{\text{PH}}^2$   $\text{Area}_{\text{PH}} = 1.98 \times 10^{18} \text{ pm}^2$

Radius of Fe atom:  $R_{\text{Fe}} := 126 \cdot \text{pm}$   $R_{\text{Fe}} = 1.26 \times 10^{-10} \text{ m}$

Area of Fe atom:  $\text{Area}_{\text{Fe}} := \pi \cdot R_{\text{Fe}}^2$   $\text{Area}_{\text{Fe}} = 4.99 \times 10^4 \text{ pm}^2$

Effective area of Fe atom:



$$\text{EffectiveArea}_{\text{Fe}} := 4 \cdot R_{\text{Fe}}^2$$

$$\text{EffectiveArea}_{\text{Fe}} = 6.35 \times 10^4 \text{ pm}^2$$

Fe atoms per pinhead:  $\text{FeAtomsPerPinHead} := \frac{\text{Area}_{\text{PH}}}{\text{EffectiveArea}_{\text{Fe}}}$   $\text{FeAtomsPerPinHead} = 3.12 \times 10^{13}$

A typical family Bible consists of 1,000 pages with an average of 5,000 characters and spaces per page. If it takes 100 Fe atoms to define a character, how many Bibles can fit on the head of a pin?

$$\text{PagesPerBible} := 1000 \quad \text{CharactersPerPage} := 5000 \quad \text{FeAtomsPerCharacter} := 100$$

Fe atoms required per bible:  $\text{FeAtomsPerCharacter} \cdot \text{CharactersPerPage} \cdot \text{PagesPerBible} = 5 \times 10^8$

$$\text{BiblesPerPinHead} := \frac{\text{FeAtomsPerPinHead}}{\text{FeAtomsPerCharacter} \cdot \text{CharactersPerPage} \cdot \text{PagesPerBible}}$$

$$\text{BiblesPerPinHead} = 6.2 \times 10^4$$

Define picometer:  $\text{pm} \equiv 10^{-12} \cdot \text{m}$