2. (a) the thickness of the book $\doteq 0.5$ inch

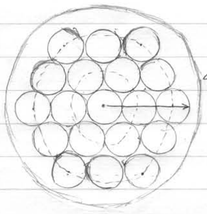
pages: about 400

so the thickness of each page : $\frac{0.5\,\text{inch}}{\frac{400}{2}} \sim 10^{-3}$ inch

(b) the diameter of pennies $\doteq 0.75$ inch

the thickness of pennies $\doteq 0.06$ inch

If we try to put the pennies into the jar as follow:



$\frac{4\,\text{inch}}{0.75\,\text{inch}} \doteq 5.3$

then we'll have $1+6+12 = 19$ pennies per layer

the total number $= 19 \times$ # of layers

$= 19 \times \frac{6\,\text{inch}}{0.06\,\text{inch}}$

$= 19 \times 100 = 1.9 \times 10^3 \sim 10^3$

And you can use square packing as well and you'll get the same order of magnitude.

(c) one page has about 2000 characters. 200 page paperback novel has $200 \times 2000 = 4 \times 10^5$ characters. Each character consumes one byte. So the number of copies is:

$$N = \frac{80 \times 10^9}{4 \times 10^5} = 2 \times 10^5 \sim 10^5$$

(There are 26 English characters. Each has 2 forms: capital & little. In the meantime, there are many other)

3. According to the SI, there're 3 base units we will use here.

distane — L

time — T

mass — M

(a) $\because [X] = [C_1 + C_2 t + C_3 t^2 + C_4 t^3] = L$ ← only quantities of the same dimension can be added together

$= [C_1] = [C_2 t] = [C_3 t^2] = [C_4 t^3]$

$\therefore [C_1] = L$

$[C_2 t] = [C_2]\,T = L \Rightarrow [C_2] = L \cdot T^{-1}$

$[C_3 t^2] = [C_3] T^2 = L \Rightarrow [C_3] = L \cdot T^{-2}$

$[C_4 t^3] = L \Rightarrow [C_4] = L \cdot T^{-3}$

(b) $[v] = [C_1] = [C_2 X] = L \cdot T^{-1}$

$\Rightarrow [C_1] = L \cdot T^{-1}$

$[C_2] = L \cdot T^{-1} \cdot L^{-1} = T^{-1}$

(c) $[X] = [C_1 \cos(C_2 t + C_3)]$ ← $\cos A = \sum_{n=0}^{\infty} (-)^n \frac{A^{2n}}{(2n)!} \Rightarrow [A^{2n}] = [A^{2m}]$ so $[A] = 1$

here $[C_2 t + C_3] = 1$

$[X] = [C_1] \Rightarrow [C_1] = L$

$[C_3] = 1$

$[C_2] = T^{-1}$

(d) $[v] = [C_1 e^{-C_2 t}]$

here $[e^{-C_2 t}] = 1 \quad [C_2 t] = 1 \Rightarrow [C_2] = T^{-1}$

$[v] = [C_1] = L \cdot T^{-1} \Rightarrow [C_1] = L \cdot T^{-1}$

$[C_2] = T^{-1}$

4. (a) According to the SI, the dimension of tension (force) is

$[F] = M \cdot L \cdot T^{-2}$

↓ tension

So we should know 3 quantities.

① the mass of the ball : m

② the radius of the circle : r

③ the period of the circular motion : T

(b) $F = C m r T^{-2}$ here C is a constant and $[C] = 1$

not unique, because C is not unique.

(c) If the mass of the ball gets very large, F becomes very large

If the speed of the ball gets very large, F becomes very large

(according to the formula above and according to your life experience.)

(d) $F' = C m r (T')^{-2} \qquad T' = \frac{T}{2}$

$= 4\,C m r T^{-2} = 4F$ (independent of C)

So the tension becomes 4 times large as it was