So, $\Delta x \geq \frac{\hbar}{m v}$ → velocity of particle.
→ mass of particle

proton's size is smallest

$$\Delta t = \frac{\text{Size of a proton}}{c \text{ (speed of light)}} \approx 10^{-23} \text{ secs.}$$

$\Delta x \approx 10^{-13}$ cm, $c \approx 3 \times 10^{5}$ km/sec.

Thus, computational steps that can be done during T → $\frac{6 \cdot 10^{17}}{10^{23}} \approx 6 \cdot 10^{40}$

10^{80} normal particles
10^{90} particles overall } If we consider all the particles are computing. Then 10^{130} steps

So, $26^{n} = 10^{130}$ $\quad (10^{1.5})^{n} \approx 10^{130}$

$n = \frac{130}{1.5} \approx 87$.

[So, input size 87 for exhaustive search]

Tuesday.
3rd March: (spring 2008 qs.)

qs1. what is computable?

To prove something is not computable, we need to have formal description of computable function.

Church's thesis: everything that can be computed by a computational device can be computed by a Java program.

— So far it is true.

So to prove that something is not computable, we can prove that this cannot be computed by Java program.

prob: Java is huge, difficult to describe. It is impossible to prove anything with Java.

So, we needed a simplified definition that will still cover all Java-computable fs. but that will ~~cover~~ be easier & thus easier to prove.

1st attempt:- natural #s, 0, for-loops, ++, assignment } ⇒ PR fn.

But are we covering all computable fns? Almost all, but not all.

2nd attempt: μ-recursive function to have while-loops.

Anything we can do by Java prog, we can do by μ-recursive f^n

So, every computable function is μ-recursive if church's theory is correct.

$\mu m\,(b+m=a)$ means smallest m for which $b+m=a$

```
m=0;
while(!(b+m==a))
{m++;}
```

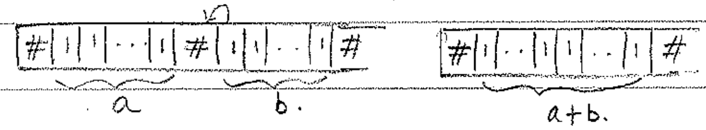
$a>b$ μ-recursive

$$\text{positive}(k) = \begin{cases} 1 & \text{if } k>0 \\ 0 & \text{otherwise} \end{cases}$$

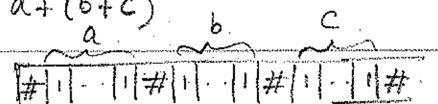
```
int pos=0;
for(i=0;i<n;i++)
{pos=1;}
```

$(a-b)>0 \rightarrow$ positive $(a-b)$ $\rightarrow$ This is PR function $\rightarrow$ Thus μ-recursive.

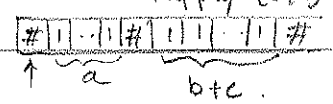
Just move 1.



$a+(b+c)$



apply $(b+c)$ here.



Then apply $a+(b+c)$ here.

$(a\%b)=c$

$\mu c\,(a$

$5\%2=1.$

$4\%2=0.$

$a = a/b + c$

$ab = a+c$

$ab - c = a$