So, \[ \Delta x > \frac{h}{mc} \] velocity of particle. 
\[ m \text{ is mass of particle} \]

Proton's size is smallest.

\[ \Delta t = \frac{\text{size of a proton}}{c} \approx 10^{-23} \text{ sec} \]

\[ \Delta x \approx 10^{-13} \text{ cm}, \quad c = 3 \times 10^5 \text{ km/sec}. \]

Thus, computational steps that can be done \[ \frac{6 \cdot 10^{17}}{10^{23}} \approx 6 \cdot 10^{-6} \]
during \( T \)

\[ 10^{80} \] normal particles. If we consider all the particles are
\[ 10^{90} \] particles overall in computing, then \( 10^{130} \) steps

So, \( 26^n = 10^{130} \)

\[ (10^{10.5})^{10} \approx 10^{130} \]

\[ n = 130 \approx 84 \]

\[ \frac{18}{10} \]

\[ \text{So, input size: 84 for exhaustive search} \]

**Tuesday, 3rd March:** (Spring 2008 Q5)

**Q5:** 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 5, 6, for loops, ++, assignment \Rightarrow \text{pr fs}.

But can we covering all computable fs? Almost all, but not all.
2nd attempt: μ-reursive function to have while-loops.

Anything we can do by Java prog, we can do by μ-reursive f.

So, μ: every computable function is μ-reursive if Church's theory is correct.

\[ \mu m \ (b + m = a) \] means smallest \( m \) for which \( b + m = a \)

\[ m := 0 \] while \( \neg (b + m = a) \)

\[ (a-b) > 0 \rightarrow \text{positive}(a-b) \] \( \rightarrow \) This is PR function \( \rightarrow \) Thus μ-reursive.

\[ \text{Just move 1.} \]

\[ \#| | | | | | | | \]
\[ a \]
\[ b. \]
\[ \text{\#} | | | | | | | | \]
\[ a+b. \]

\[ a + (b + c) \]
\[ a \]
\[ b. \]
\[ c \]

\[ \#| | | | \]
\[ \text{apply } (b+c) \text{ here.} \]
\[ \#| | | | \]
\[ \text{Then apply } a + (b + c) \text{ here.} \]
\[ \#| | | | \]
\[ \text{a} \]
\[ b+c. \]

\[ (a \cdot b) = c. \]
\[ 5 \% 2 = 1. \]
\[ a \cdot b = a + c. \]
\[ 4 \% 2 = 0. \]
\[ ab - c = a. \]