1)

a)

i) 4000x4000 —> 2000x4000 —> 2000x2000 —> 1000x2000 —> 1000x1000 —> 500x1000 —> 500x500 —> 250x500 —> 250x250 —> 125x250 —> 62.5x125 —> 62.5x62.5 —> 31.25x62.5 —> 31.25x31.25 —> 15.625x31.25 —> 15.625x15.625 —> continues….

You're halving the paper each time so to halve 4000 to around 1 takes 22 folds. You need to do that to both sides so it takes 44 folds to get about 1 meter on each side.

ii) you are doubling the thickness 24 times. So an originally 0.1mm thick piece of paper will be

\[(0.1) \times 2^{44} = 1.75 \times 10^2 \text{ mm thick}\]

iii) 62.5x62.5

b) Need to type in $10^{15}$ characters to create a petabyte. Assuming you don't sleep, eat, and can just type indefinitely

\[10^{15} \text{ seconds} \times (1 \text{ min/60 sec}) \times (1 \text{ hour/60 min}) \times (1 \text{ day/24 hour}) \times (1 \text{ year/365 days}) =\]

about

\[31 \times 10^6 \text{ years so it is not an exaggeration.}\]

c)

\[365 \text{ days} \times (24 \text{ hours/1 day}) \times (60 \text{ minutes/1 hour}) \times (60 \text{ seconds/minute}) \times 40 \text{ Tb/sec} =\]

\[31 \times 10^6 \text{ seconds} \times 40 \text{ Tb/sec} = 1.3 \times 10^9 \text{ Tb}\]
1.3 \times 10^9 \text{ Tb} \times (1 \text{ byte/8 bits}) = 1.57 \times 10^{20} \text{ bytes of }

2)

get
print
wow sub 1
print
ifzero hey
ifpos wow
hey stop

b)

M1
Sum 0
Val 0
Get
Top ifzero done
Store Val
Add Sum
Load Val
Sub M
3) 

a) If there are many people in line with just one item each:

N is the number of people in line

\[ 41 * N + (N*3) = 44N \]

\[ 41 + (3*M) \]

Can create an instance such that

\[ 44 N > 41 + 3M \]

If \( N = 10 \) and \( M = 20 \)

440 sec > 101 sec

b) 

Times I spend in line:

shopping, at a stop light, things like the DMV, getting gas.

I shop about once a week and that takes me on average 5 minutes of waiting.
When I drove a lot I'd drive everyday and would be at stoplights for about 1 minute per stoplight and would hit an average of 15 stoplights in a day.

Administrative things like the DMV are rarer, twice in a year, and take about 1 hour of waiting.

Getting gas is once a week and takes 3 minutes of waiting usually.

In a year I'd wait:

\[5 \times 52 + 15 \times 365 + 60 \times 2 + 3 \times 52 = \text{about } 6000\]

So \[3 \times 10^8 \times 6000 = 18 \times 10^{11} = 2 \times 10^{12}\] minutes

37 billion hours would be

\[3.7 \times 10^{10} \text{ hours} \times 60 \text{ minutes/hour} = 24 \times 10^{11} \text{ minutes} = 2.4 \times 10^{12}\] minutes.

So that estimate is about right as a guess.