Conner Wulf _ HW1

1	3GHz	1.5
2	2.5GHz	1.0
3	4.0GHz	2.2

1. a) P1: 3GHz/1.5 = 2×10^9 IPS (Instructions per second)
P2: 2.5GHz/1.0 = 2.5×10^9 IPS
P3: 4 GHz / 2.2 = 1.82×10^9 IPS
* P2 Has the highest performance

B) Cycles:
P1: 3GHz x10 = 3×10^{10} cycles
P2: 2.5 x10 = 2.5×10^{10} cycles
P3: 4 x 10 = 4×10^{10} cycles

Instructions:
P1: 3×10^{10} cycles/1.5 = 2×10^{10}
P2: $2.5 \times 10^{10} / 1.0 = 2.5 \times 10^{10}$
P3: $4 \times 10^{10} / 2.2 = 1.82 \times 10^{10}$

c) $\text{CPU Time} = \dfrac{\text{Instruction Count} \times \text{CPI}}{\text{clock frequency}}$

$\text{CPU Time} \times 0.7 = \dfrac{(\text{Instruction count} \times (\text{CPI} * 1.2))}{\text{New clock frequency}}$

New clock frequency = old clock frequency (1.2/0.7)

P1: 3 GHz x $\left(\frac{1.2}{0.7}\right)$ = 5.13 GHz
P2: 2.5 GHz x (1.2/.7) = 4.27 GHz
P3: 4 GHz x (1.2/.7) = 6.84 GHz

2. P1: Cpu Time $= \dfrac{(100{,}000 \times 1) + (200{,}000 \times 2) + (500{,}000 \times 3) + (200{,}000 \times 3)}{2.5 \times 10^9}$

$$\text{Cpu Time} = \frac{2.6 \times 10^6}{2.5 \times 10^9} = 1.04 \times 10^{-3}\,s$$

P2: cpu time $= \dfrac{(100{,}000 \times 2) + (200{,}000 \times 2) + (500{,}000 \times 2) + (200{,}000 \times 2)}{3 \times 10^9}$

$$\text{Cpu time} = \frac{2 \times 10^6}{3 \times 10^9} = \frac{2}{3} \times 10^{-3}\,s$$

P2 implementation is faster than P1 because the cpu time is smaller

a) Global CPI of P1:

$$CPI = \frac{\sum_{i=1}^{n} (CPI_i \times C_i)}{\sum_{i=1}^{n} C_i} = \frac{2.6 \times 10^6}{1 \times 10^6} = 2.6$$

cycles count calculated above

Global CPI of P1 is 2.6

Global CPI of P2:

Using the CPI equation above

$$\frac{2 \times 10^6}{1 \times 10^6} = 2$$

Global CPI of P2 is 2

B) P1: Clock cycles is 2.6×10^6
P2: Clock cycles is 2×10^6 → Calculated above at begining

3a) 1 processor $(2.56\times10^9 \times 1) + (1.28\times10^9 \times 12)(256\times10^6 \times 5)$

1 processor 1.92×10^{10} cycle count

cpu time $= \frac{1.92\times10^{10}}{2\times10^9} = \frac{19.2}{2} = 9.6$ seconds

2 processors

2 processors $\frac{2.56\times10^9 \times 1}{0.7\times2} + \frac{1.28\times10^9\times12}{(0.7\times2)} + (256\times10^6\times5) =$

1.404×10^{10} cycle count

cpu time $= \frac{1.404\times10^{10}}{2\times10^9} = \frac{14.04}{2}$ 7.02 seconds

$\frac{9.6 \text{ seconds}}{7.02 \text{ seconds}} = 1.37$ x's relative speed up

4 processors

4 processors $\frac{2.56\times10^9\times1}{.7\times4} + \frac{1.28\times10^9\times12}{0.7\times4} + 256\times10^6\times5 = 7.72\times10^9$

cpu time $= \frac{7.72\times10^9}{2\times10^9} = 3.86$s. $\frac{9.6\text{s}}{3.86\text{s}} = 2.49$x's realive speed up

8 processors $\frac{2.56\times10^9\times1}{.7\times8} + \frac{1.28\times10^9\times12}{.7\times8} + 256\times10^6\times5 = 4.5\times10^9$

cpu time $= \frac{4.5\times10^9}{2\times10^9} = 2.25$ sec. $\frac{9.6\text{s}}{2.25\text{s}} = 4.27$x's realive speed up.

3B) 1 processor

Clock cyle $= 2.176\times10^{10}$

cpu Time $= \frac{2.176\times10^{10}}{2\text{GHz}} = 10.88$ Secs

2 processors

Clock cycles $= 1.59\times10^{10}$

cpu Time $\frac{1.59\times10^{10}}{2\text{GHz}} = 7.954$s

from the Calculations from the one processor & 2 processors we can say that the cpu Time increases if the Arithmetic instruction was doubled

3C. the CPI of load and Store should be reduced by 25%

4) a) FP Instruction time = 70 s

70s − (70 × 0.2)

New FP time: 70s − 14s = 56s

New Total Time = 56s + 85s + 40s + 55s = 236

difference in time 250s − 236s = 14s

$\frac{14s}{250s} = 0.056 \times 100 = 5.6\%$

the total time is reduced by 5.6% if the FP instructions are reduced by 20%.

B) 250s − (250 × .2)

New total Time: 250s − 50 = 200

New Int Time = 200 − 40 − 70 − 85 = 5s

$\frac{50}{55} = 0.9 \times 100\%$

the INT Instruction time was reduced by 90%.

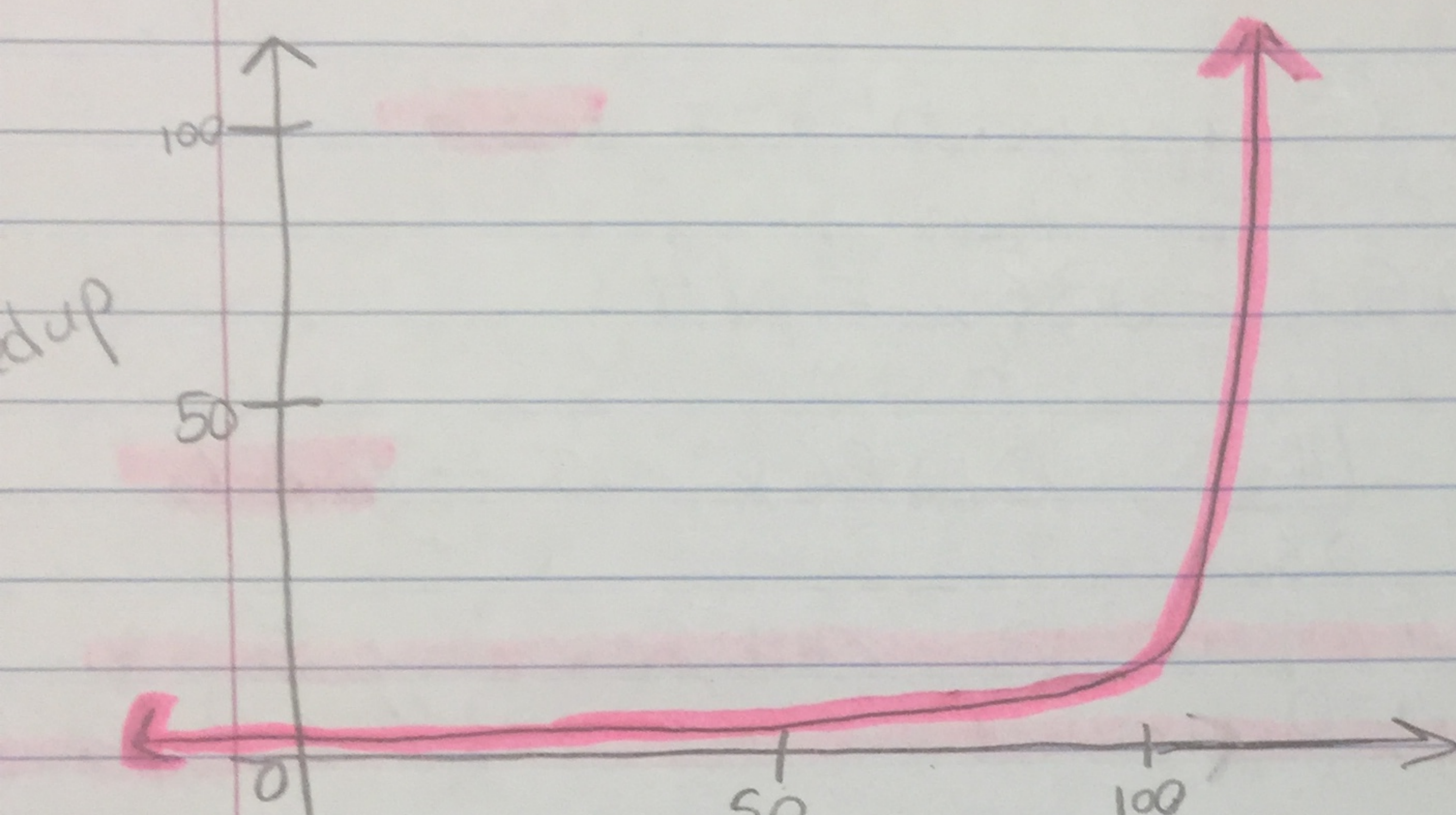
c). for the total time to reduce by 20% the following equation must be true.

200 = 70 + 85 + 55 + 40x where x equals the percentage reduced.

200 = 210 + 40x

Since this equation is not true the total time cannot be reduced by 20% by only reducing the branch instruction time

5.) A) $\text{Speedup}_{overall} = \dfrac{1}{\frac{(1-f)}{100} + \frac{f}{10 \times 100}} = \dfrac{1}{1-.009f}$



B) $2 = \dfrac{1}{1-\frac{9f}{1000}}$ $\quad \dfrac{1}{2} = 1 - \dfrac{9f}{1000} = \dfrac{-9f}{1000} = \dfrac{-1}{2}$

$f = \dfrac{1}{\cancel{2}} \times \dfrac{\cancel{1000}^{500}}{9}$ $\quad f = \dfrac{500}{9} = 55.55\%$

to achive a speed up of 2, 55.55% of vectorization is needed.

c) 55.55%

D) $5 = \dfrac{1}{1-\frac{9f}{1000}}$ $\quad \dfrac{4}{5} = \dfrac{9f}{1000}$ $\quad f = \dfrac{4}{5} \times \dfrac{1000}{9} = \dfrac{800}{9}$ 88.8

88.8% of vectorization is required to achieve 1/2 the max speedup attainable.

6. A) $\underset{\text{(unaccelerated)}}{50\%} + \underset{\text{(accelerated without enhancement)}}{500\%} = 550\%$

Overall speed up $= \frac{550\%}{100\%} = 5.5$ times

B) $\frac{(5.5 \times 10) - 10}{5.5 \times 10 - 5.5} = \frac{45}{49.5} = 90.9\%$

90.9% of the original execution time has been converted to fast Mode.