HW #1

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1. a: P1: $\frac{3.5\times10^9 \text{ clocks}}{1s} \cdot \frac{1 \text{ instruct}}{1.5} = 2.33\times10^9$ instruction / second

P2: $\frac{2.8\times10^9 \text{ clocks}}{1s} \cdot \frac{1 \text{ instruct}}{1} = 2.8\times10^9$ instructions / second

P3: $\frac{4.0\times10^9 \text{ clocks}}{1s} \cdot \frac{1}{2.2} = 1.82\times10^9$ instructions / second

$\boxed{\text{P2 has the highest performance}}$

b: P1: $2.33\times10^9 \cdot 20 = \boxed{4.67\times10^{10} \text{ instructions}}$
$\times$ 1.5 cycles $= \boxed{6.99\times10^{10} \text{ cycles}}$

P2: $2.8\times10^9 \cdot 20 = \boxed{5.6\times10^{10} \text{ instructions}}$
$\times$ 1 $= \boxed{5.6\times10^{10} \text{ cycles}}$

P3: 1.82×10^9 instructions $\times 20 = \boxed{3.64\times10^{10} \text{ instructions}}$
$\times 2.2 = \boxed{7.99\times10^{10} \text{ cycles}}$

C: Cpu time $= \frac{\text{Instruc C} * \text{CPI}}{\text{CR}}$ ~~14~~ ~~Et~~ ~~$= \frac{IC \cdot 1.15\text{ CPI}}{X \cdot CR}$~~

~~1492 20s = IC · CPI · CR~~

$14s = IC \cdot 1.15\text{ CPI} / X \cdot CR$

P1: $14s = (4.67\times10^{10}) \cdot 1.15(1.5) / X \cdot 3.5\times10^9$

$X = 1.644$ New $\boxed{CR = 5.75\times10^9 \text{ Hz}}$

P2: $14s = 5.6\times10^{10} \cdot 1.15(1) / x \cdot 2.8\times10^{9}$

$x = 1.642$ $\boxed{\text{New CR} = 4.6\times10^{9}\ Hz}$

P3: $14s = 3.64\times10^{10} \cdot 1.15(2.2) / x \cdot 4\times10^{9}$

$x = 1.6449$ $\boxed{\text{New CR} = 6.58\times10^{9}\ Hz}$

2 a: P1 Avg $CPI = 1(.1) + 2(.2) + 3(.4) + 4(.3) = 2.9$

$2.8\times10^{9} / 2.9 = 9.66\times10^{8}$ instructions / second

P2 Avg $CPI = 2(.1) + 3(.2) + 2(.4) + 3(.3) = 2.5$

$3.5\times10^{9}/2.5 = 1.4\times10^{9}$ instructions / second

[P2 is faster because it can handle the dataset quicker]

b: P1 global $= 1(.1) + 2(.2) + 3(.4) + 4(.3) = \boxed{2.9\ CPI}$

P2 global $= 2(.1) + 3(.2) + 2(.4) + 3(.3) = \boxed{2.5\ CPI}$

c: P1: $2.9\ CPI \cdot 1\times10^{6}$ instructions $= \boxed{2.9\times10^{6}\ \text{cycles}}$

P2: $2.5\ CPI \cdot 1\times10^{6}$ instructions $= \boxed{2.5\times10^{6}\ \text{cycles}}$

3 A: comp A: CPU time $= I/p \cdot CPI \cdot 1\times10^{-9}s$

$1.1 = 1\times10^{9} \cdot CPI \cdot 1\times10^{-9}s$ $\boxed{CPI = 1.1}$

comp B: CPU time $= 1.4 = 1.3\times10^{9} \cdot CPI \cdot 1\times10^{-9}s$

$\boxed{CPI = 1.08}$

b: comp A = 1.0s = $1\times10^9 * 1.1$ / CR | $\boxed{CR = 1.1\times10^9\ Hz}$
Comp B = 1.0s = $1.3\times10^9 * 1.08$ / CR | $\boxed{CR = 1.404\times10^9\ Hz}$
[compiler B is 1.28 times faster than compiler A]

C: Execution time = $6\times10^8 * 1.1 / 1\times10^9$ = .66 s
.66/1.1 = .6 new is 40% faster than A
.66/1.4 = .47 new is 53% faster than B

4. ~~10s~~ ~~15s~~
~~15s = 1×10^9 Hz~~ $15\times1\times10^9$ = Clock cycles
15×10^9 clocks cycles $\times 1.2 = 1.8\times10^{10}$ clock cycles
10s = 1.8×10^{10} clock cycles / CR
CR = 1.8×10^9 Hz

5. A: Average cpi: Total instructions = 5.256×10^9
arithmetic = 57.08% Load = 38.05% branch = 4.87%
Avg CPI = 1(.5708) + 10(.3805) + 5(.0487)
= 4.62 CPI

~~1 Processor: Et = $5.256\times10^9 \cdot 4.62 / 2\times10^9$ = 12.14 s~~
~~2 Processor: Total instructions = $\frac{2\times10^9}{0.8\times2} + \frac{3\times10^9}{0.8\times1} + 256\times10^6$~~

~~1 Processor: Total = $\frac{2\times10^9}{0.8} + \frac{3\times10^9}{0.8} + 256\times10^9 = 2.6225\times10^{11}$~~
~~Et = $2.6225\times10^{11} \cdot 4.62 /$~~

1 processor: $Et = 5.256\times10^9 \cdot 4.62 / 2\times10^9 = 12.14$ s

2 processor: $\frac{3\times10^9}{0.8\times2} + \frac{2\times10^9}{2\times0.8} + 256\times10^6 = 3.381\times10^9$

$Et = 3.381\times10^9 \cdot 4.62/2\times10^9 = 7.81$ s

$1 - \frac{7.81}{12.14} = .36$ $\boxed{\text{2 processor is 36\% faster}}$

4 processor: $\frac{3\times10^9}{0.8\times4} + \frac{2\times10^9}{0.8\times4} + 256\times10^6 = 1.82\times10^9$

$Et = 1.82\times10^9 \cdot 4.62/2\times10^9 = 4.2$ s

$1 - \frac{4.2s}{12.14s} = .65$ $\boxed{\text{4 processor is 65\% faster}}$

8 processor: $\frac{3\times10^9}{0.8\times8} + \frac{2\times10^9}{0.8\times8} + 256\times10^6 = 1.037\times10^9$

$Et = 1.037 \cdot 4.62 / 2\times10^9 = 2.40$ s

$1 - \frac{2.40}{12.14} = .80$ $\boxed{\text{8 processor is 80\% faster}}$

b: 1 processor: $Et = 8.256\times10^9 \cdot 4.62/2\times10^9 = 19.07$

$19.07/12.4 = $ $\boxed{\text{1.57 times slower}}$

2 processor: $\frac{6\times10^9}{0.8\times2} + \frac{2\times10^9}{2\times0.8} + 256\times10^6 = 5.256\times10^9$

$Et = 5.256\times10^9 \cdot 4.62/2\times10^9 = 12.14$ s

$12.14/7.81 = $ $\boxed{\text{1.55 times slower}}$

4 processor: $\frac{6\times10^9}{0.8\times4} + \frac{2\times10^9}{0.8\times4} + 256\times10^6 = 2.756\times10^9$

$Et = 2.756\times10^9 \cdot 4.62/2\times10^9 = 6.37s$

$6.37/4.2 = \boxed{1.52 \text{ times slower}}$

8 processor: $\frac{6\times10^9}{0.8\times8} + \frac{2\times10^9}{0.8\times8} + 256\times10^6 = 1.506\times10^9$

$Et = 1.506\times10^9 \cdot 4.62/2\times10^9 = 3.47886\,s$

$3.47886/2.40 = \boxed{1.46 \text{ times slower}}$

C: $\frac{(3\times10^9 + X + 256\times10^6)\cdot 4.62}{2\times10^9} = 4.2s$

$X = \boxed{-1.44\times10^9 \text{ instructions}}$

6 A: P1: $\frac{0.9\times5\times10^9}{4\times10^9} = 1.125s$

P2: $\frac{0.75\times1\times10^9}{3\times10^9} = .25s$

This not true because P2 has lower CR but it has faster CPU time

B: P1: $\frac{0.9\times1\times10^9}{4\times10^9} = .225s$

P2: $\frac{0.75\times X}{3\times10^9} = .225s$

$\boxed{X = 9\times10^9 \text{ instructions}}$

C: P1: $CR \cdot \frac{1}{CPI} = \frac{4.44 \times 10^9 \text{ instructions/s}}{10^6} = \boxed{4444.44 \text{ MIPS}}$

P2: $CR \cdot \frac{1}{CPI} = \frac{4 \times 10^9}{10^6} = \boxed{4000 \text{ MIPS}}$

This is false because we showed that P2 can do the program faster.

D: P1: $\frac{2 \times 10^9}{1.125 \times 10^6} = 1777.78$ MFLOPS

P2: $\frac{4 \times 10^8}{.25 \times 10^6} = 1600$ MFLOPS

This is misleading because we know P2 is faster