1.-a

$$A: \frac{1.1s}{1.0E9 \times 1ns} = 1.1$$

$$B: \frac{1.5s}{1.2E9 \times 1ns} = 1.25$$

1.-b

$$\text{execution time} = \text{CPU time} = \frac{\text{instructions} \times CPI}{\text{clock rate}}$$

$$\text{execution time}_1 = \text{execution time}_2,$$

$$\frac{\text{instructions}_1 \times CPI_1}{\text{clock rate}_1} = \frac{\text{instructions}_2 \times CPI_2}{\text{clock rate}_2}$$

$$\text{clock rate}_1 = \frac{\text{instructions}_1 \times CPI_1}{\text{instructions}_2 \times CPI_2} \times \text{clock rate}_2$$

$$= \frac{10^9 \times 1.1}{1.2 \times 10^9 \times 1.25} \times \text{clock rate}_2$$

$\therefore$ clock rate$_1$ = 0.73 clock rate$_2$

Answer) 27%

1.-c

$$\text{new compiler}: \frac{6.0E8 \times 1.1 \times 10^{-9}s}{1s} = 0.66$$

$$A: \frac{1.1}{0.66} = 1.6666\cdots \fallingdotseq 1.67$$

$$B: \frac{1.5}{0.66} = 2.2727\cdots \fallingdotseq 2.27$$

2-a

one processor,

$$\text{clock cycles} = (2.56 \times 10^9) \times 1 + (1.28 \times 10^9) \times 12 + (256 \times 10^6) \times 5 = 1.92 \times 10^{10}$$

$$\text{execution time} = \frac{1.92 \times 10^{10}}{2 \times 10^9} = 9.6s$$

$p > 1$ processors,

$$\text{clock cycles}_p = \frac{2.56 \times 10^{10}}{p} + 1.28 \times 10^9$$

$$\text{execution time}_p = \frac{\frac{2.56 \times 10^{10}}{p} + 1.28 \times 10^9}{2 \times 10^9} = \frac{12.8}{p} + 0.64$$

p	1	2	4
execution time in seconds	9.6	7.04	3.84
speed-up	1	1.36	2.5

2-b.

$$\text{execution time} = \frac{2.176 \times 10^{10}}{2 \times 10^9} = 10.88s$$

Let $p > 1$, $\text{clock cycles}_p = \frac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9$

$$\text{execution time}_p = \frac{\frac{2.93 \times 10^{10}}{p} + 1.28 \times 10^9}{2 \times 10^9} = \frac{14.6s}{p} + 0.64$$

p	1	2	4
execution time in seconds	10.88	7.965	4.3025
slow-down	1.13	1.13	1.12

2-c.

$$\text{execution time}_{new} = 3.84s = \frac{\text{clock cycles}_{new}}{2GHz}$$

$$\therefore \text{clock cycles}_{new} = 2 \times 10^9 \times 3.84 = 7.68 \times 10^9$$

$$= 2.56 \times 10^9 + 1.28 \times 10^9 \times CPI_{2,new} + 256 \times 10^6 \times 5$$

$$\therefore CPI_{2,new} = \frac{7.68 \times 10^9 - 3.84 \times 10^9}{1.28 \times 10^9} = 3$$

3-a

Answer)

2004 : $\frac{90W}{(1.25V)^2 \times 3.6GHz} = \frac{90}{1.25^2 \times 3.6\times10^9} \approx 14.52nF$

2012 : $\frac{40W}{(0.9V^2)\times 3.4GHz} = \frac{40}{0.9^2 \times 3.4\times10^9}$

3-b.

$P_{static} + P_{dynamic} = P_{total}$

2004 : 10W + 90W = 100W

2012 : 30W + 40W = 70W

Answer)

	2004	2012
$\frac{P_{static}}{P_{total}}$ (percentage)	10%	$\frac{30}{70} \times 100 \doteqdot 42.8\%$
$\frac{P_{static}}{P_{dynamic}}$ (ratio)	$\frac{10}{90}$	$\frac{30}{40}$

3-C.

$I_L = 8A$, $\frac{P_{new}}{P_{old}} = \frac{V_{new}I_{Lnew} + C_L(V_{new})^2 f}{100W} = 0.9$

$\therefore V_{new} \frac{-8A + \sqrt{(8A)^2 - 4(57.6\frac{A}{V})-90W}}{2(57.6\frac{A}{V})}$

$V_{new} = 1.18V$, which represents a reduction of about 5.4% over the original 1.25 volts.

the core is Ivy Bridge, we find the $V_{new} = 0.48V$, a reduction of 6.51%.

4-a

0.8 × 70s = 56s

250(70−56) = 236s

Answer) 236s

4-b.

0.8×250 = 200s

200−70−85−40 = 5s

$\frac{5}{55} = 0.09 \;\therefore\; 91\%$

Answer) 91%

4-c.

55+70+85 = 210

$\frac{210}{250} = 0.84 \rightarrow 18\%$

Answer) No, we can't reduce the branch hours by 20% by reducing the branch hours alone.