CS M151B HW 1 Junhong Wang (504941113)

1.5

a. P1 : $3 \cdot 10^9$ cycles / sec , 1.5 cycles / instruction.

$$3 \cdot 10^9 \cdot \frac{2}{3} = 2 \cdot 10^9 \text{ instructions / sec}$$

P2 : $2.5 \cdot 10^9$ cycles / sec , 1 cycle / instruction

$$2.5 \cdot 10^9 \cdot \frac{1}{1} = 2.5 \cdot 10^9 \text{ instructions / sec}$$

P3 : $4.0 \cdot 10^9$ cycles / sec , 2.2 cycles / instruction

$$4.0 \cdot 10^9 \cdot \frac{5}{11} = \frac{20}{11} \cdot 10^9 \text{ instructions / sec}$$

$\therefore$ P2 has the highest instructions per second.

b. P1 : (Number of cycles) = $3 \cdot 10^9 \cdot 10$

$= 3 \cdot 10^{10}$

(Number of instructions) = $2 \cdot 10^9 \cdot 10$

$= 2 \cdot 10^{10}$

P2 : (Number of cycles) = $2.5 \cdot 10^9 \cdot 10$

$= 2.5 \cdot 10^{10}$

(Number of instructions) = $2.5 \cdot 10^9 \cdot 10$

$= 2.5 \cdot 10^{10}$

P3 : (Number of cycles) = $4.0 \cdot 10^9 \cdot 10$

$= 4.0 \cdot 10^{10}$

(Number of instuctions) = $\frac{20}{11} \cdot 10^9 \cdot 10$

$= \frac{20}{11} \cdot 10^{10}$

c.

$$ET = IC \cdot CPI \cdot CT$$

$$\Leftrightarrow \quad 0.7\,ET = IC \cdot 1.2\,CPI \cdot \frac{0.7}{1.2}\,CT$$

Since $(\text{Clock Rate}) = \frac{1}{CT}$, $\quad CR_{New} = \frac{1.2}{0.7}\,CR_{Old}$.

P1 : $\frac{1.2}{0.7} \cdot 3 \approx \boxed{5.14\ [GHz]}$

P2 : $\frac{1.2}{0.7} \cdot 2.5 \approx \boxed{4.29\ [GHz]}$

P3 : $\frac{1.2}{0.7} \cdot 4.0 \approx \boxed{6.86\ [GHz]}$

1.6

a. $(\text{P1's global CPI}) = 0.1 \cdot 1 + 0.2 \cdot 2 + 0.5 \cdot 3 + 0.2 \cdot 3$

$= 0.1 + 0.4 + 1.5 + 0.6$

$= 2.6$

$(\text{P2's global CPI}) = 0.1 \cdot 2 + 0.2 \cdot 2 + 0.5 \cdot 2 + 0.2 \cdot 2$

$= 2$

b. P1: $2.6 \cdot 1.0 \cdot 10^6 = \boxed{2.6 \cdot 10^6 \text{ [cycles]}}$

P2: $2 \cdot 1.0 \cdot 10^6 = \boxed{2.0 \cdot 10^6 \text{ [cycles]}}$

$$(\text{Execution Time for P1}) = \frac{2.6 \cdot 10^6}{2.5 \cdot 10^9}$$

$$= \frac{2.6}{2.5 \cdot 10^3} \text{ [sec]}$$

$$(\text{Execution Time for P2}) = \frac{2.0 \cdot 10^6}{3.0 \cdot 10^9}$$

$$= \frac{2}{3 \cdot 10^3} \text{ [sec]}$$

$\therefore$ P2 is faster.

1.7

a. Compiler A : $ET_A = IC_A \cdot CPI_A \cdot CT$

$1.1 = 1.0 \cdot 10^9 \cdot CPI_A \cdot 1.0 \cdot 10^{-9}$

$\boxed{CPI_A = 1.1}$

Compiler B : $ET_B = IC_B \cdot CPI_B \cdot CT$

$1.5 = 1.2 \cdot 10^9 \cdot CPI_B \cdot 1.0 \cdot 10^{-9}$

$\boxed{CPI_B = \frac{1.5}{1.2} = 1.25}$

b. $ET = IC \cdot CPI \cdot CT$

$$IC_A \cdot CPI_A \cdot CT_{P1} = IC_B \cdot CPI_B \cdot CT_{P2}$$

$$1.0 \cdot 10^9 \cdot 1.1 \cdot CT_{P1} = 1.2 \cdot 10^9 \cdot 1.25 \cdot CT_{P2}$$

$$1.1\ CT_{P1} = 1.2 \cdot 1.25\ CT_{P2}$$

$$\frac{CT_{P2}}{CT_{P1}} = \frac{1.1}{1.2 \cdot 1.25}$$

$$\approx 0.73$$

$\therefore$ Clock of the processor running compiler A's code is $0.73\times$ faster (i.e. slower) than Clock of the processor running compiler B's code.

C. $ET_c = IC_c \cdot CPI_c \cdot CT$

$= 6.0 \cdot 10^8 \cdot 1.1 \cdot 1.0 \cdot 10^{-9}$

$= 0.66$ [sec]

$\frac{EA_A}{ET_c} = \frac{1.1}{0.66} \approx 1.67$

$\frac{ET_B}{ET_c} = \frac{1.5}{0.66} \approx 2.27$

The new compiler is 1.67 x faster than compiler A.

The new compiler is 2.27 x faster than compiler B.

1.13

1. FP : 70 s

L/S : 85 s

branch : 40 s

INT : 55 s

$$70 \cdot 0.2 = \boxed{14 \ [s]}$$

2.

$$250 \cdot 0.2 = \boxed{50\ [s]}$$

3. No, because only 40 s spent on branch instructions, but we need 50 s to achieve 20% total reduction.