Q2)

a) $I.P.S = \frac{\text{Clock rate}}{CPI}$

IPS for P1 $= \frac{3\ GHz}{1.5} = 2 \times 10^9$

IPS for P2 $= \frac{2.5\ GHz}{1} = 2.5 \times 10^9$

IPS for P3 $= \frac{4\ GHz}{2.2} = 1.82 \times 10^9$

Therefore, P2 is the one with highest performance in IPS.

b) no. of instructions = IPS x CPU Time (Always 10 in this case)
no. of cycles = CPU Time (10) x clock rate

P1:
instructions $= 2 \times 10^9 \times 10 = 2 \times 10^{10}$
cycles $= 10 \times 3 \times 10^9 = 3 \times 10^{10}$

P2:
instructions $= 2.5 \times 10^9 \times 10 = 2.5 \times 10^{10}$
cycles $= 10 \times 2.5 \times 10^9 = 2.5 \times 10^{10}$

P3:
instructions $= 1.82 \times 10^9 \times 10 = 1.82 \times 10^{10}$
cycles $= 10 \times 4 \times 10^9 = 4 \times 10^{10}$

c) Execution time $= \frac{\text{cycles}}{\text{clock rate}}$ or $\frac{\text{instruction} \times CPI}{\text{clock rate}}$

0.7(old execution time) = new execution time

Q2)

c) Continued:

$$0.7\left(\frac{\text{instruction}_1 \times CPI_1}{\text{clock rate}_1}\right) = \frac{\text{instruction}_2 \times CPI_2}{\text{clock rate}_2}$$

the number of instructions stays the same, so we can cancel it out:

$$0.7\left(\frac{CPI_1}{\text{clock rate}_1}\right) = \frac{CPI_2}{\text{clock rate}_2} \quad \text{and} \quad CPI_2 = 1.2\, CPI_1:$$

$$\frac{0.7}{\text{clock rate}_1} \Rightarrow \frac{1.2}{\text{clock rate}_2} \Rightarrow 0.7\,\text{clock rate}_2 = 1.2\,\text{clock rate}_1$$

$$\Rightarrow \text{clock rate}_2 = \frac{1.2}{0.7}\,\text{clock rate}_1 = 1.71\,\text{clock rate}_1$$

The clock rate must increase by 71%.